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Vol 2. No. 9 Pittsburgh, Pa. September, 1929

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KALMAN J. DE JUHASZ

Measurements—Industrial and Scientific.
DR. WALTER BLOCK

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- New Model 547 Radio Set Tester
- New Tachometer Generator
- Substation Switchboard Circular-Chart Recorder
- Miniature Portable Precision Instruments
- New Electric Engine Indicator and Spark Plug
- A Demonstration of Physical Testing and Recording
- New Meter Service Breaker
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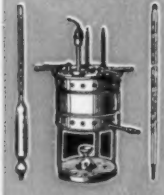

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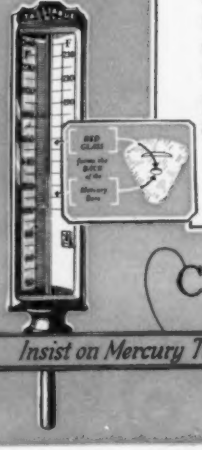

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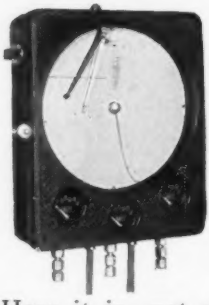

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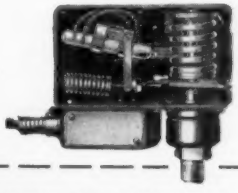

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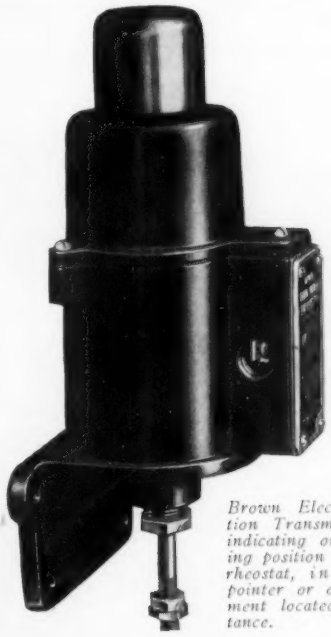

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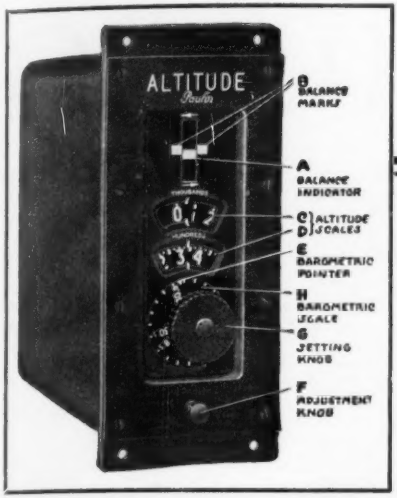

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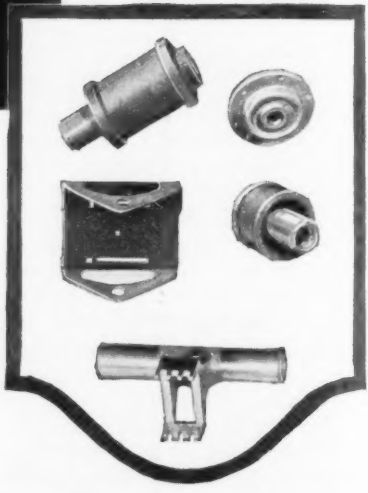

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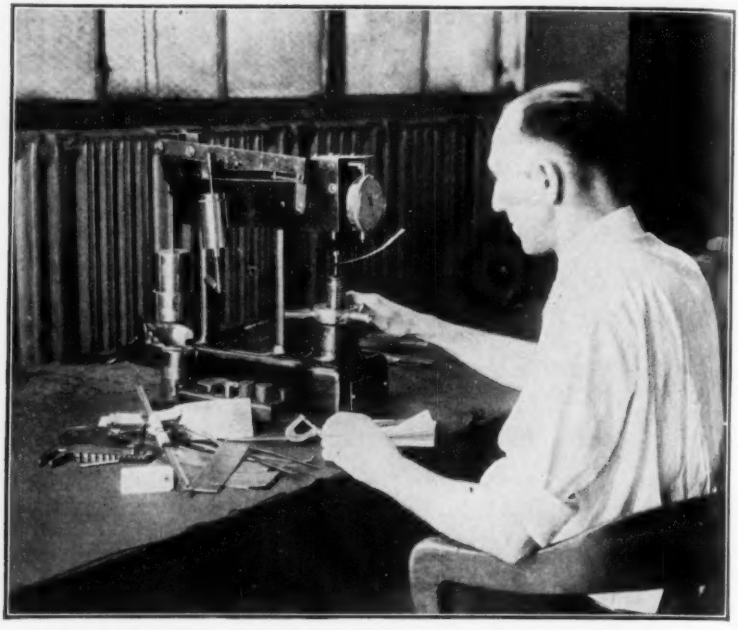

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Vol. 2, No. 9 SEPTEMBER, 1929 Pittsburgh, Pa.

To Our Readers

THE editor has just returned from an extensive trip visiting various instrument manufacturers and inspecting their work shops. What he saw was most interesting and will interest every user of instruments.

Some of the users of instruments, especially in the teaching profession, have a very limited idea of the capability of the American instrument manufacturers to manufacture special scientific instruments. This idea would be dispelled if they would visit some of our American manufacturers' plants and see for themselves the things that the editor had the opportunity of seeing.

This naturally has a very definite bearing upon the tariff on scientific and industrial instruments and it was with this in mind that the trip was made.

American instruments are replacing those of foreign manufacture regardless of the fact that the foreign instruments are cheaper in price. This will be the case wherever the man considering the purchase of an instrument will take the trouble to fairly compare by actual use the foreign with the American. Aside from the fact that there is a tremendous economy of time incident to an immediate service, obtainable from American manufacturers as compared to the long delay in the case of foreign instruments—it will be found that in most cases the American design is mechanically better and more serviceable.

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Announcing a New Series

INSTRUMENTS has secured the complete rights for publication in the English language of a new book on measuring and weighing by Dr. Walter Block. There are many comprehensive books on measurements, usually so written that they are of advantage only to the specialist, but not so suitable for the engineer and practical man who may only occasionally be called upon to make certain measurements.

The preface and table of contents of the volume appears in this issue, and subsequent chapters will appear every month. We venture to think that we are rendering engineers a distinct service in submitting a transla-

tion of the most recent work on this subject. The object of the author's work has been to present, in a simple straightforward manner, information on measurements for the men, who are only occasionally required to perform certain measurements. While the greatest value of this series undoubtedly will be for these men, specialists will also find the text helpful.

As regards the editor's own task as translator, his chief object will be to present a faithful interpretation of the original, and will therefore subordinate the style of the work to the all important consideration of accuracy. The opinions expressed are the author's own, the translator's responsibility being confined to their faithful rendering in English.

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Some Instruments Used for Oil Spray Study

*Kalman J. DeJuhasz***

THE problem of making the Diesel engine more dependable, more economical in operation and more adaptable for various duties is closely connected with the control of the properties of the oil spray as it is injected into the combustion space of the engine. On the smallness of the oil particles, on their distribution in the combustion space and on the timing of discharge depend the pressures and temperatures to which the engine parts are subjected, the completeness with which the chemical energy of the fuel is transformed into mechanical work and the completeness of utilization of both fuel and air in the combustion process.

For this reason it is of paramount importance to know the properties of the oil spray. The Oil Spray Laboratory at Penn State has been established for the purpose of carrying out investigations in this field.

It is not convenient, and in many respects not even possible to investigate the oil spray in the engine itself. Therefore special equipment has been constructed in the laboratory to produce oil sprays under conditions simulating those in the engine and which admit the possibility of their investigation. Apparatus has been built up for measuring the velocity of spray, the rate of discharge, the pressure change occurring during injection and other spray properties. As the injection takes place at several thousand pounds per square inch pressure, the velocities attain several hundreds of feet per second and the duration of the injection is extremely short, therefore considerable difficulties had to be surmounted in the development of the equipment.

In the following some of these instruments will be described:

I. Recording Pendulum for Measuring the Momentum of the Oil Spray and Its Mean Velocity.

The momentum of the oil spray can be determined by shooting it against the center of gyration of a pendulum in a manner similar to the ballistic pendulum tests for the determination of the speed of bullets. The impact takes place in accordance with the law of inelastic bodies and the pendulum is deflected. From the known mass of the pendulum, and from its deflection the momentum of the spray can be determined.

The ballistic pendulum principle has already been used in oil spray investigations.*

The previous equipment of the experiment station was used in some tests and gave consistent results. After the suitability of the principle for oil spray tests had been proved by the means of this apparatus, it seemed desirable to further develop this device and include the following features:

*"Versuche an der Oeleinspritzung in der Dieselmachine." M. Riehm. Zeitschrift Verein deutscher Ingenieure, June 20, 1924 and "Oil Spray Investigations at Penn State College." P. H. Schweitzer. The Penn State Engineer, Dec. 1927; Mechanical Engineering, Transactions of the A. S. M. E., Gas & Oil Power, 1928.

**Asst. Prof. of Engineering Research, Pennsylvania State College.

1. Continuous changing of the distance between the nozzle and the impact plate. The distance changing mechanism to be operable from the outside of the pressure chamber.
2. Small dimensions in order to reduce the size of the compressed air chamber required for the housing of the apparatus. This is a desirable feature resulting in ease of handling and in economy in compressed air consumption.
3. Automatic recording of the pendulum displacement as a function of the distance from the nozzle.

On these lines the apparatus shown on the accompanying drawing (Fig. 1) has been designed. It consists of the following three main component parts:

(a) The carriage on which the pendulum proper is mounted;
(b) The bed upon which the carriage runs;
(c) The recording mechanism.

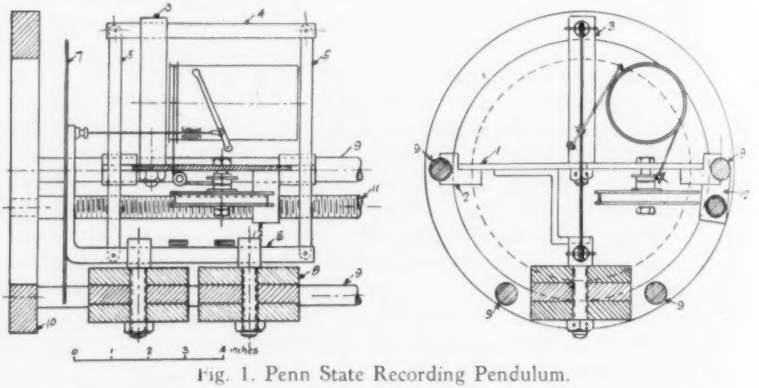


Fig. 1. Penn State Recording Pendulum.

The carriage consists of a horizontally arranged rectangular plate (1) having four sliding shoes (2) at the four corners. On the pillar (3) a horizontal beam (4) is arranged, on the two ends of which two strips of steel (5) constituting the pendulum arms are fulcrumed. To the lower end of the pendulum arms an L shaped rod (6) is pivoted. The pivots are formed by pieces of thin piano wire inserted into the forked ends of the beam and L rod and into eyelets of the pendulum arms through carefully drilled holes. This construction has the merit of simplicity and small friction.

The L rod is the pendulum proper and to its vertical arm an easily interchangeable impact plate (7), to its horizontal arm the interchangeable weights (8) are attached. Two adjustable stops limit the movement of the pendulum. It will be observed that all these swinging parts execute not a rotary but a circular translatory motion, all parts (except the two steel strip arms which have a negligible weight) remaining always parallel to their initial position. This arrangement has the merit of the impact plate at all times remaining vertical and consequently perpendicular to the axis of the spray nozzle. Furthermore, that the change of the weight does not affect the zero position of the pendulum, nor the radius of gyration, which remains, at all times equal to the

length of the pendulum arm. In the present design the largest usable impact plate is 7″ diameter and the length of the pendulum arms is 6″.

The bed consists of four parallel, horizontal bars (9) inserted at the two ends into two base rings (10) thus forming the skeleton of a half hexagonal prism. The two upper bars arranged diametrically opposite to one another form the runway upon which the carriage is sliding. The purpose of the two lower bars is to stiffen the bed against bending under the influence of the carriage weight and vibration. Rotatable, in bearings drilled into the two base rings a lead screw (11) is arranged carrying a nut (12) which is prevented from rotating by means of an extension engaging with the carriage. Rotating the lead screw thus causes a movement of the carriage on a lathe. The lead screw can be rotated from outside of the pressure chamber by means of a hand crank carried through a stuffing box (not shown). A revolution counter arranged on this crank (not shown) indicates the exact position of the carriage inside the chamber.

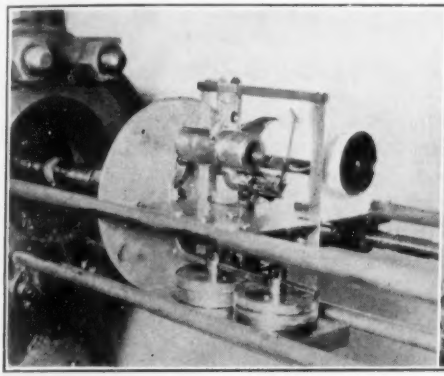


Fig. 2. Photo of Penn State Recording Pendulum.

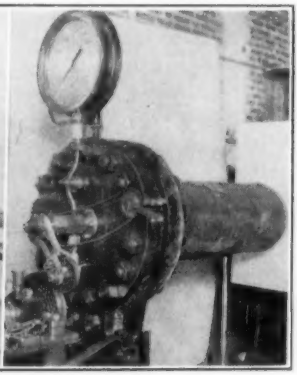


Fig. 3. Photo of Pressure Chamber Complete.

The recording mechanism is constructed from a normal steam engine indicator. It is bolted to the pillar (3) of the carriage. Its pencil arm is actuated by the pendulum through an extension of the L rod. In order to compensate between the circular path of the pendulum and the rectilinear path of the crosshead of the pencil arm, the connection between these two is arranged by a piece of piano wire. The recording mechanism gives in the present apparatus a five fold magnification of the pendulum displacement.

The drum of the indicator is rotated by means of a string in the usual manner, one end of it being attached to the drum pulley and the other to some fixed point on the base ring. Through the interposition of a small and a large pulley a reduction of one to five is provided in order to accommodate the travel range of the carriage (17 inches) to the size of the paper. Thus the card taken shows the momentum of the spray as ordinate on the basis of the distance from the spray nozzle as abscissa.

A light sheet steel cover is placed over the carriage in order to protect the indicator card from the oil spray.

Mounting and Operation of the Pendulum. The pendulum is mounted by bolting one of the base rings to the frame holding the oil spray nozzle coaxially with the latter. The whole outfit is of such dimensions that all parts fall within a cylinder of 8½" diameter, consequently a 9" internal diameter high pressure steam pipe or a similar container can be employed as a pressure chamber.

The tests are carried out in such a manner that with the spray mechanism running at a given constant speed, say 300 r.p.m., injections are made at an initial pressure of 1,000 lbs./sq. in. at distances of 0, 100, 200, 300, 400 mm. Then using the same card, injections are made at 2,000 lbs./sq. in. initial pressure at 5, 105, 205, 305, 405 mm. distances, and so on, a series of injections at 3,000, 4,000, 5,000 and 6,000 lbs./sq. in. oil pressures are carried out and recorded on the card with a slight staggering of 5 mm. of the distance at each series. The staggering of the abscissa points keeps the ordinates distinct so that a connecting line can be drawn through the ends of each.

If injections into compressed air, say at 500, 400, 300, 200 and 100 lbs./sq. in. are to be investigated, the whole apparatus can be enclosed

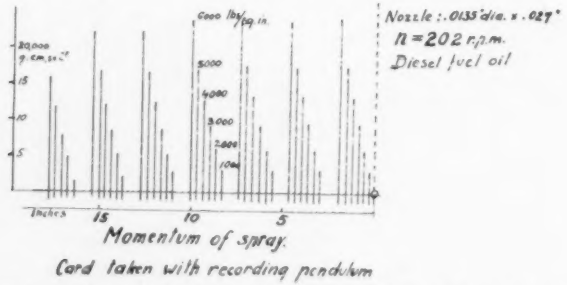


Fig. 4. Specimen Card of Oil Spray Momentum, taken with Penn State Recording Pendulum. (Full size.)

within the pressure chamber after fixing the paper on the indicator drum. The further operation is similar to that described above. After each series of tests the chamber must be opened and the card taken out.

The method of slight staggering and thus keeping the ordinates distinct can be carried further in this case, making injections at different air pressures with the same original air change, and record them on the same card. This method results in economy of both amount of air used and time. It causes no difficulty to recognize each ordinate as to the oil pressure and air pressure to which it belongs, provided a certain predetermined system of shifting is adhered to and the sequence of injections noted. It is desirable, however, to dissolve into separate cards the composite card thus obtained after it has been taken out of the chamber and so to avoid confusion. It is not difficult to keep track of the different ordinates, as the revolution counter attached to the lead screw handle indicates at all times the exact distance of the impact plate from the nozzle orifice.

For the correct evaluation of the cards special care must be taken for the exact determination of the co-ordinate axes. The abscissa axis can be

determined by slightly tapping the apparatus and thus eliminating the friction. The position of the pencil point then indicates the abscissa axis. It is advantageous to determine this point at several locations of the carriage.

The ordinate axis is determined by approaching the carriage towards the nozzle until the impact plate just touches the end of the nozzle.

Error Sources

The more important of these are

1. Solid friction
2. Fluid friction

The Solid friction in the pendulum parts themselves in negligible owing to the use of very small diameter piano wire pivots. A more serious source of error is the friction in the recording mechanism, i. e., the friction in the crosshead guide of the magnifying mechanism, friction in the joints and, most important of all, the friction between the pencil and paper. This latter must be kept at a low value by keeping the pressure between paper and pencil extremely light and to obtain lines which are just visible. It is advantageous to use highly glazed indicator paper. The card should be inspected and the end lines drawn in shortly after it has been taken off from the drum, as the original lines are liable to fade. The possibility of error from this source is estimated approximately 5 per cent on the basis of check tests with different weights. Slight variation of pencil pressure does not influence the results seriously, in other words, with ordinary care consistent results can be obtained.

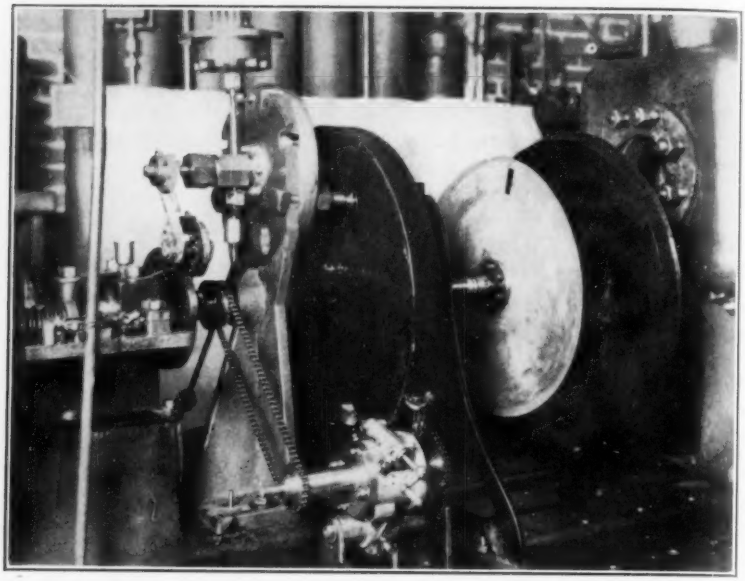
The effect of *fluid friction* caused by the resistance of air against the motion of the plate, could not be experimentally investigated up to the present. Its magnitude depends on the velocity of the impact plate and therefore its value can be reduced by employing small plate velocities, i. e., large weights. In the present design the velocity of the plate is of the order of magnitude 5-10 cm. sec. and no serious error from fluid resistance is anticipated in the air densities corresponding to pressures up to 500 lbs./sq. in.

Conclusions. The specimen cards shown in this report are examples of the results which can be obtained by means of the apparatus described. These and similar results show the suitability of the apparatus for the investigation of momentum, mean speed and penetration of the oil spray.

II. The Spray Stroboscope.

Neither the rate of fuel discharge nor the velocity of the spray is a constant quantity. The variation of both during the injection period has an important influence on the indicator card and, in turn, on the specific fuel consumption of the engine.

In order to investigate these two quantities an equipment was developed based on the principle of the stroboscopic disc and shown in Figs. 5 and 6. It consists essentially of a circular disc of 20″ diameter rotating in front of the orifice at a short distance therefrom (approx. 1/16 inch). On this disc, in the following to be referred to as "window disc," a small window corresponding to two degrees of arc is provided. The disc is positively driven from the camshaft actuating the injection valve (or other spray producing mechanism, i. e., jerk pump) in such a manner that the window is brought in front of the orifice always in the



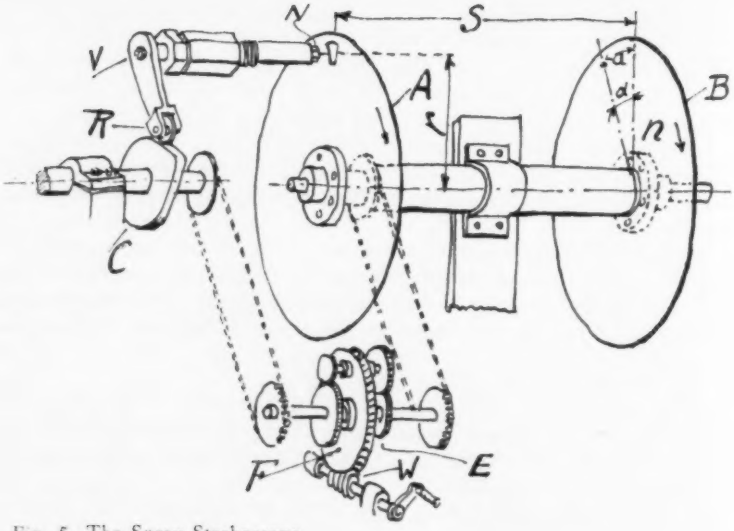


Fig. 5. The Spray Stroboscope.

N = nozzle
C = cam
R = roller

V = valve spindle
A = window disc

B = target disc
E = epicyclic gear, ratio 2:1

F, W = worm gear

$$\text{Velocity of spray} = \frac{s}{t} = \frac{s}{\frac{\alpha}{360} \cdot \frac{60}{n}} = \frac{6\,sn}{\alpha} = \frac{sr\pi n}{30\alpha}$$

same phase of the injection period. When the window is in front of the nozzle a part of the spray can pass through the window, and can be caught in a cup. During the rest of the injection period the spray strikes against the disc and is intercepted. In order to change the phase under test and so to be able to test each phase of the injection period, the window disc is not driven directly from the camshaft itself, but through the interposition of an epicycle gearing. One shaft of the latter is driven from the camshaft, the other drives the window disc, while the third member, preferably the spider wheel, can be turned manually by means of a worm wheel drive. In the present equipment the epicyclic gearing fulfills, besides shifting the phase, also the function of a 2: 1 transmission, thus doubling the speed of the stroboscopic disc. This results in a quicker opening up and cut off of the spray by the window. Chain and sprocket drive is used for transmission and the worm gear acting on the epicyclic spider is provided with a counter on which the phase under test can be read off. Owing to the two to one transmission the cut off portion of the spray which passes through the window corresponds to one degree of camshaft rotation. Weighing the amount of oil passing through the rate of discharge at various phase angles can be determined.

The spray velocity can be measured by the same equipment but with the addition of another disc keyed upon the shaft of the window disc at a known axial distance from it. The latter disc to be referred to in the following as "target disc" is provided with degree gradations. The portion of the jet passing through the window hits the target disc after a time element, necessary to traverse the distance between the two discs, has elapsed. As during this time element the disc has rotated a certain angle, there will be an angular lag between the point opposite to the windows (to be referred to in the following as "zero point"), and the point at which the jet hits the target disc. Assuming

S = distance between the two discs
t = time necessary to traverse S at
v = spray velocity
α = angular lag
n = r.p.m. of disc

Then the velocity can be expressed by the following formula:

$$v = \frac{s}{t} = \frac{6sn}{\alpha}$$

Error Sources of the Apparatus. The spray velocity decreases during the passage of the spray through the atmosphere. The above described method gives the mean velocity within the range between the two discs. From this consideration it is desirable to reduce the distance S between the two discs to as low a value as compatible with obtaining sufficiently large and distinct readings for α. The reduction of the distance is especially desirable if tests are to be made under dense air conditions, i. e., when the negative acceleration of the spray is considerable. Up to the present the oil spray experiments were made solely under atmospheric conditions, when the retardation is inconsiderable within the range which has practical importance from an engineering point of view, i. e., within twenty or thirty inches from the orifice.

On the other hand it is desirable to reduce the observational error in the reading of the lag angle α. This can be attained by making its arc value large, i. e., the disc of large diameter. From structural considerations this is, however, not desirable, especially if it is intended to use such apparatus inside a pressure chamber.

The accuracy of the velocity determination depends to a great extent on the accuracy of the reading of the value of lag. Suppose that in this reading an error $d\alpha$ be committed, owing to faulty observation or faulty determination of the zero point. The resulting error dv in the value of velocity is to be determined:

$$v = \frac{6 s n}{\alpha}$$

$$\frac{dv}{d\alpha} = -6 s n \frac{1}{\alpha^2}$$

Then the absolute error:

$$dv = 6 s n \frac{1}{\alpha^2} d\alpha$$

It is seen that the absolute error in v decreases in a quadratic fashion with the increase of the value α.

The relative, or percentual error is obtained by dividing the absolute error by the total value:

$$\frac{dv}{v} = -\frac{d\alpha}{\alpha}$$

It is seen that the relative error in the velocity is equal to the relative error in the measurements of α.

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Books on Instruments and Devices
for Measurement, Inspection and Control

NOTE:—Instruments' Book Shelf is prepared to supply any book or periodical.

MICROSCOPY AND OPTICS

THE MICROSCOPE: Its Design, Construction and Application. F. S. Spiers. 1920. Cloth, 260 pages, $8.00.

THE MICROSCOPE. A SIMPLE HANDBOOK. Conrad Beck. 1923. Cloth, 144 pages, $1.25.

THE MICROSCOPE. AN ADVANCED HANDBOOK. Conrad Beck. 1924. Cloth, 231 pages, $2.50.

THE MICROSCOPIC ANALYSIS OF METALS. F. Osmond and J. Stead. 1924. Cloth, 313 pages, $5.00.

MICROSCOPIC DETERMINATION OF THE ORE MINERALS. W. Davy and C. Farnham. 1920. Cloth, 154 pages, $2.50.

TEXTILE MICROSCOPY. L. G. Lawrie. 1928. Cloth, 139 pages, $7.50.

SPECTROSCOPY. E.C.C. Baly. Vol. I, 1924. Cloth, 298 pages, $5.00; Vol. II, 1927. Cloth. 398 pages, $6.00; Vol. III. 1927. Cloth, 532 pages, $7.50.

METALLOGRAPHY. Cecil H. Desch. 1922. Cloth, 452 pages, $5.00.

PHOTOMICROGRAPHS OF IRON AND STEEL. E. L. Reed. 1929. Cloth, 253 pages, $4.00.

IMPURITIES IN METALS. C. Smithells. 1928. Cloth, 157 pages, $5.00.

ELEMENTARY CHEMICAL MICROSCOPY. E. M. Chamot. 1921. Cloth, 479 pages, $4.25.

ELEMENTS OF OPTICAL MINERALOGY. N. H. & A. N. Winchell. Part I. Principles and Methods. 1922. Cloth, 216 pages, $3.50. Part II. Description of Minerals. 1927. Cloth, 424 pages, $5.50.

ELEMENTS OF OPTICS. J. Valsek. 1928. Cloth, 215 pages, $2.00.

THE TELESCOPE. Louis Bell. 1920. Cloth, 285 pages, $3.00.

EXPERIMENTAL OPTICS. Albert F. Wagner. 1929. Cloth, 203 pages, $3.25.

PHOTOMETRY

LIGHT, PHOTOMETRY AND ILLUMINATING ENGINEERING. W. Barrows, 1925. Cloth, 412 pages, $4.00.

ELECTRICAL PHOTOMETRY AND ILLUMINATION. Hermann Bohle. 1925. Cloth, 427 pages, $11.00.

Measurements
Industrial & Scientific
An Instruction Book for Engineers

DR. WALTER BLOCK
Eichungsdirektor der Provinz Ostpreussen

with an introduction

The Historical Development of the Measuring Science and the Systems of Length and Weight

by

DR. FRITZ PLATO
Director a. d. Reichsanstalt fuer Mass und Gewicht

with 109 Figures in the Text.
1928

PREFACE

THE completion of this treatise, sad to say has taken a very long time. Originally its preparation was taken over by *Dr. Plato,* at that time director of the German Institute of Weights and Measures (*Reichsanstalt fuer Mass und Gewicht*). His official activities after the war, as well as the extensive work, caused by the incorporation of the German Institute of Weights and Measures in the more recent German Bureau of Standards (*Physikalisch-Technischen Reichsanstalt*), left him very little time to devote to the work. Then as he retired, he decided to discontinue this work, and in agreement with the publishers the continuation was taken over by the author. The latter, also, due to his official duties was prevented from completing the manuscript until a very much later time than was originally planned.

Dr. Plato turned over to me the part written by him, ready for publication. There was no reason why this part should not be used, and it was therefore incorporated in the treatise, without any changes worth mentioning and makes up the first chapter of this work.

The rest of the book was completely written by the author.

There is no dearth of instruction and handbooks on measurements in the literature. On the contrary, one finds many of the most varied kinds, many excellent and not so good. The well known handbook of *Kohlrausch,* which every engineer who is specially interested in the measuring science has learned to know and value, must be especially mentioned. It creates the impression though that this handbook, in spite of this, is somewhat difficult for those who are not continually concerned with measurements, so that for these it is hardly possible or too laborious to make full use of the information presented. To a research physicist it presents no difficulties, but it probably does to engineers, who are only

*See editorial on page 297.

occasionally required to perform difficult measurements. The small manual of *Kohlrausch* would be more suitable for these, but it does not appear to be wholly satisfactory.

All these instruction books of the measuring science usually have the one point in common, they are largely reference books, respectively collections of recipes. This cannot necessarily be designated as a defect, but for the engineer, who has not been specially trained, it always means making the work more difficult. I therefore proceeded in this treatise, so as to give it more the character of an instruction book.

For this reason the book lays no claims to completeness. I have knowingly omitted many things, which doubtless belong in a handbook of the measuring science, and covered more completely those measurements used most frequently by the engineer. Therefore the chapters on measurement of volume, weight, thickness, length, temperature with the mercury thermometer are thoroughly covered, while other chapters, in comparison with these, are treated briefly or in part omitted altogether. One will search in vain for the measurement of color or the measurement of potentials with standard electrodes. This was done, as I assumed that a person, with experience as to how measurements should be carried out, can obtain the information from handbooks especially devoted to these subjects. This treatise is only to give a simple and detailed introduction as to how basic measurements are carried out and, in fact how measurements, which require a higher degree of dependability are projected.

In how far these considerations are of use in practice, and if the book will be of value, only experience will tell.

BLOCK.

Koenigsberg, Jan. 1, 1928.

CONTENTS

I. The Historical Development of the Science of Measurement and the Essence of Weights and Measures.
II. General Information on Measurements and Their Performance.
III. Measuring Systems and General Physical Constants.
IV. Measurement of Time.
V. Measurement of Angles.
VI. Measurement of Length.
VII. Measurement of Area.
VIII. Measurement of Volume.
IX. Weighing.
X. Measurement of Thickness.
XI. Measurement of Pressures.
XII. Measurement of Humidity.
XIII. Measurement of Temperature.
XIV. Measurement of Heat Quantity.
XV. Measurement of Light Intensity.
XVI. Optical Measurements.
XVII. Electrical Measurements.

(Continued in the October Issue)

NEW INSTRUMENTS

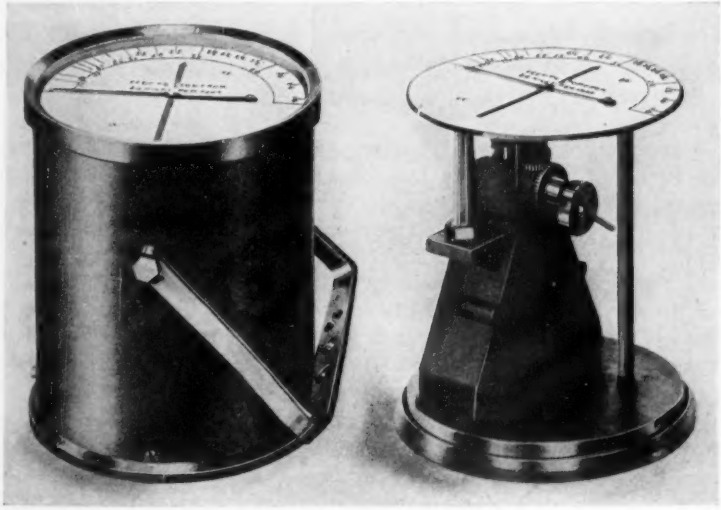
Recently Developed by Instrument Manufacturers

Write Information Section, Instruments Publishing Co., Pittsburgh, Pa., for additional information

The James Brake Inspection Decelerometer

(American Instrument Company)

THE most universal method of brake inspection in present use is that in which the operator drives to a line marked on the road and applies his brakes. The distance from this line to the point where he comes to a full stop is supposedly a measure of his brake efficiency. The method is open to criticism because the accuracy of the driver's speedometer is unknown; the driver may and usually does miss the line by several feet, sometimes applying his brakes too early and at other times too late. The driver has so many things in mind at the moment he should be giving his entire attention to stopping in the shortest possible distance that the results of the tests are doubtful. In other words, the accuracy of tests depends on the driver, an element most objectionable. All traffic experts agree that the test is a poor makeshift and has been used only because no better substitute could be found.



The James Brake Inspection Decelerometer avoids all these difficulties. The test may be made at any reasonable speed on any stretch of road, and no reference marks are needed on the road. The instrument reads the

distance in feet in which the car will stop from a speed of 20 miles per hour regardless of the actual speed; in other words, it makes no difference whether the car speed is 15, 20, or 25 miles per hour, the instrument interprets the results as though the car were traveling at 20 miles per hour. All results thus reduced to the same basis, the test is a simple one to perform, and all results are comparable.

The method of making the test is as follows: Set the instrument on the floor of the car, with the direction arrow pointing along the line of the direction of the car motion (i.e., towards the front). Accelerate to any desired speed and apply the brakes with as much force as possible. The pointer will indicate the stopping distance from 20 miles per hour, and will remain there long enough for an accurate reading to be made, usually two or three seconds.

The instrument is very carefully constructed and calibrated. It should last indefinitely with the proper care. The shocks and vibrations of ordinary use do not affect it. The principle on which the instrument operates is based upon the fundamental laws of motion; which are incontrovertible.

The Decelerometer is cylindrical in form, as shown in the cut, and is about 6 inches in diameter and 7 inches high, weight of instrument about ten pounds. For traffic departments where the distance to stop is fixed by law, the dial can be marked in red at the critical distance. All tests above the red line pass inspection, while all below are rejected.

It is designed for use of Fleet Owners, Bus Lines, Taxicab Companies, Police Authorities, Service Stations, Garages, Manufacturers of Automobiles, Research Engineers, Electric Street Cars, and in general for those whose duty it is to inspect brakes.

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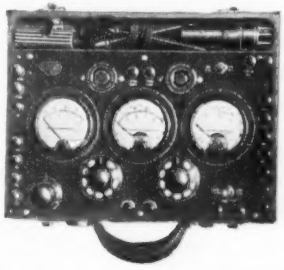
With Vincent Bendix as chairman of the board, Orvill W. Thompson, President, and Walter J. Buettner, Secretary and Treasurer, the General Instruments Corporation has been formed to direct and operate the James P. Marsh Company of Chicago, the American Paulin System, Inc., of Los Angeles, and the Tiffany Manufacturing Company of Newark. Negotiations are also in progress for the absorption of other companies which will give General Instruments Corporation a most complete line of automotive, aviation, engineering and technical instruments. The Vice Presidents are H. E. Linden, C. W. Curtis and H. L. Blackman. The other member of the board is N. Bard.

Products of General Instruments Corporation have been used by many famous flyers, such as Commander Byrd, Capt. Hawkes, Kingsford Smith, Sir Hubert Wilkins and Parker Cramer. For continued advance in the art of making precision instruments, General Instruments Corporation will operate a fine research laboratory under the direction of Commander Guy K. Calhoun, who during the World War had charge of the development of such devices as gyroscopes and submarine detectors.

New Model 547 Radio Set Tester

(*Weston Electrical Instrument Corporation*)

THE Model 547 was designed to meet the more advanced servicing needs of radio's latest developments. Model 547 embodies several features making for greater convenience and speed of operation. It is ingeniously designed, and will render a precise, comprehensive character of service. Model 547 is contained in a rugged bakelite case provided with a carrying handle and a compartment for housing the set accessories and a few small tools. It has a removable, snap-on cover—the overall size is 12¾x9x3¾ inches and the weight is approximately 10 pounds. The panel on which the instruments and switches are mounted is of moulded bakelite as well as the instrument cases, switches, binding posts, test sockets and tester plug. The instrument equipment consists of three 3¼" diameter Weston models; an eight range D. C. Model 301 for 750/250/100/50/10/5 volts, 100/5 milliamperes —a double range D. C. Model 301 for 100/20 milliamperes and a five range A. C. Model 476 for 750/150/16/8/4 volts. All ranges with the exception of the 750/150 A. C. voltage ranges are made available by means of three rotary switches at the Tester Plug which is permanently attached to the set by flexible cable. All voltage and the 100/20 milliampere ranges are also brought out to binding posts for use in making external tests using the flexible leads provided with the set. Two sockets are provided on the panel, a UX and a UY. The tester plug has four prongs and an adapter is provided to change it to a five-prong plug. All voltage and the 100/20 milliampere ranges are brought out to binding posts—the D. C. voltage and current ranges are brought to binding posts at the right and the A. C. ranges to binding posts at the left. Two binding posts and a 4½ volt C battery are provided for use in making a continuity test with either a high or low resistance voltmeter (1,000 or 100 ohms per volt). The resistance is changed by means of a toggle switch.



A complete book of instructions is supplied with each tester which also includes test data for many manufactured sets.

Some of the service tests that can be made with the Weston Model 547: Simultaneous readings can be made of the heater voltages on the A. C. voltmeter and the plate current on the milliammeter, while plate, grid bias, cathode or screen voltages or the grid, screen or rectifier currents are being measured on the D. C. volt-milliammeter.

Tests with tester plug inserted in the radio set:

Filament voltage, +10 or —10 volts on the D. C. voltmeter.

Heater voltages, 16/8/4 on the A. C. voltmeter.

Plate voltages, 750/250 volts on the D. C. voltmeter.

Bias voltages, for grid at tube base, ±100 or ±50 volts on D. C. voltmeter.

"C" bias voltages, D. C. sets with reversed filaments, 50 volts on D. C. meter.

Cathode voltages, +50 or —50 volts on D. C. voltmeter.

Control grid voltages, —5 or +100 volts on D. C. voltmeter.

Plate current ranges, 100/20 M.A. on the D. C. milliammeter.

Screen current range, 5 M.A. on the D. C. volt-milliammeter.

Grid test on A. C. or D. C. screen grid tubes and '27 used as detector.

Simultaneous readings of the currents of both plated of full wave rectifier tubes.

External tests using binding posts and flexible cables:

Measurement from center tap of power transformer, 750 volts on A. C. meter.

Line voltage measurements, 150 volts on A. C. meter.

Heater voltages at power pack, 16/8/4 volts on A. C. meter.

Plate current at various "B" supply taps, 100/20 M.A. on milliammeter.

"B" supply at power pack, 750/250 volts on D. C. voltmeter.

"A," "B," "C" battery voltages, 50/10/5 volts on D. C. voltmeter.

Continuity tests, using the self contained 4.5 "C" battery and with either 1,000 or 100 ohms per volt resistance in voltmeter circuit. Resistance measurements, the voltmeter as used for continuity tests also serves as a direct reading ohmmeter. The instruction card carries a table which converts deflection in volts into ohms for the unknown resistance.

Values for condenser measurements given in instruction book.

Measurement of trickle chargers and other devices, the milliammeter 20 range may be shunted for 10 or 2 amperes.

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Books on Instruments and Devices for Measurement, Inspection and Control

NOTE:—Instruments' Book Shelf is prepared to supply any book or periodical

FLOW MEASUREMENT

MEASUREMENT OF AIR FLOW. E. Ower, 1928. Cloth, 194 pages, $5.00.

MEASUREMENT, COMPRESSION & TRANSMISSION OF NATURAL GAS. L. C. Lichty. 1924. Cloth, 523 pages, $7.50.

A TREATISE ON CHEMICAL ENGINEERING APPLIED TO THE FLOW OF INDUSTRIAL GASES, STEAM, WATER, AND LIQUID CHEMICALS. Geoffrey Martin. 1928. Cloth, 447 pages, $14.00.

MESSUNG GROSSER GASMENGEN. L. Litinsky. 1922. Cloth, 274 pages, $5.00.

THE MEASUREMENT OF FLUID VELOCITY AND PRESSURE. J. R. Pannell. 1924. Cloth 148 pages, $4.00.

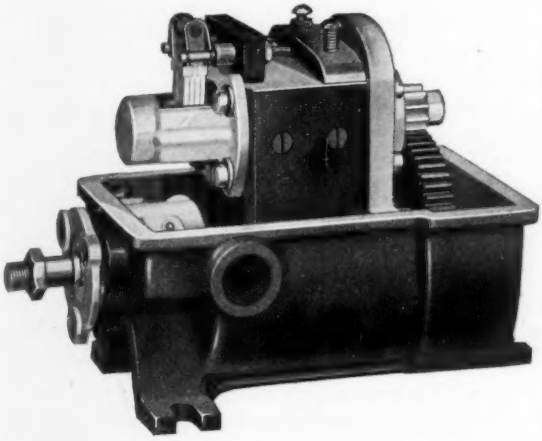
DIE GRUNDLAGEN DER DAMPFMESSUNG NACH DEM DIFFERENZDRUCKPRINZIP. W. Germer. 1927. Paper, 60 pages, $1.00.

New Tachometer Generator

(Esterline-Angus Company)

THIS tachometer generator embodies in its design those items which produce a rugged and reliable machine, which can be installed with minimum expense.

Simplicity of Drive. Reference to the accompanying illustration will show that the generator has an intermediate shaft carried in heavy ball bearings which is in turn geared to the armature shaft. This arrangement has two main features. It relieves the armature of all strains due to the drive, and also makes it possible to drive the armature at the most advantageous speed by the use of different gear ratios between the intermediate and armature shaft. As a result the generator may be furnished for direct connection to machines of different speeds. These generators can be coupled direct to the shaft having maximum speeds as low as 200 rpm., as well as machines having a maximum speed of 5000 rpm. With such a range, it is seldom necessary to provide outside gear reductions or special drives of any kind. Where direct connection is impossible, the generator can be driven by means of a flat belt, silent chain or gear.



The generator is contained in a cast aluminum case which has two compartments, one for the gears, and the other for the electrical parts. The lower half of the case is designed so as to accurately locate all the parts. A stuffing box is provided about the shaft. The case has three feet so as to prevent strains in mounting.

The upper half forms a cover, which can be removed and replaced without disturbing any mechanical parts or electrical connections. A gasket forms a tight joint between the case and the cover, so that the whole is dust, gas and water tight. Terminal openings are provided in each side of the case, into which are fitted insulated binding posts. These openings are tapped for standard half inch conduit, and when desired, the binding post on one side can be removed and the conduit screwed into the opening.

The Iron-Clad Armature. To produce a steady voltage which is directly proportional to the speed through a wide range requires a special design of the armature and magnetic circuit. In this design we have succeeded in overcoming the tendency of the magnetism to pulsate as the armature is rotated. The voltage is smooth and steady at all speeds. The eddy currents in the pole pieces have been reduced to a minimum, thereby overcoming the tendency of the voltage curve to droop at high speeds. The windings are well insulated from the core, and are placed in slots which are almost closed, which protects them from injury. The windings are thoroughly impregnated with elastic varnish, and securely bound in place.

The armature is carried on high grade ball bearings, which require a minimum of lubrication, while maintaining a uniform airgap between the armature and the pole pieces.

The Commutator and Brushes. Of equal importance to the armature in speed measuring generators, are the commutator and brushes. After exhaustive tests, we have arrived at a combination of metals and a construction which overcomes the difficulties which have been inherent in practically all machines offered for this class of service.

The commutator is made of an alloy which is glass hard, eliminating wear of the segments. It is held true to shape by heavy steel rings, shrunk over each end. Its construction is such that grease from the bearings does not find its way to the commutator surface.

The brushes are of special design, which overcomes any tendency to vibrate. They can be removed and replaced while the machine is running, without any tools whatever. Construction is such that the brushes come accurately to position when removed and replaced.

The Magnetic Field. The magnetic field is produced by a permanent magnet of large cross-section and long length. The polar space is accurately bored, and the mounting of the gearings is such as to locate the armature accurately between the poles.

The cross-section of iron in the armature core is large, and the magnetic leakage so reduced that large masses of iron brought near the generator do not affect the voltage. The magnet is mounted with the poles upward, so that the generator can rest on an iron base. An adjustable metal shunt is placed across the poles of the magnet, which further stabilizes the magnetic field, and permits of adjustments of the voltage, to bring the set into vibration.

Higher Voltage Increases Accuracy. In the past, generators for speed measurement have been designed to produce approximately six volts at a speed of one thousand rpm. With so low a voltage, the errors due to armature and brush contacts, leads, etc., were considerable. The Esterline-Angus generator develops approximately sixteen volts at one thousand rpm., which results in a more reliable and more accurate instrument.

Substation Switchboard Circular-Chart Recorder

RECENT developments in switchboard panels are reflected in instrument design; and not the least of the requirements lies in the demand for absolute conservation of space. This has brought the rectangular type of instrument much to the fore; and the Bristol Company is now offering a small-sized round-chart recorder, which fills the need for voltmeters and ammeters in modern sub-station practice. In the development of the instrument, the Bristol Company has enjoyed the cooperation of one of the largest and most progressive utilities in America; and it has been possible to confirm all design features by exhaustive tests under protracted service conditions.

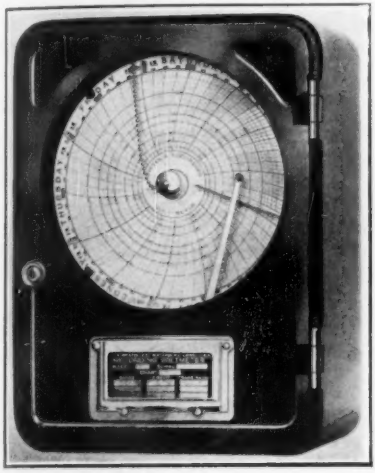


Fig. 1

While the instrument constitutes a marked advance in the development of recorders, no basically novel principles are involved; and all the elements involved have been proved by years of service in older types of Bristol recorders. The general appearance of the instrument is well exemplified in the voltmeter illustrated in Fig. 1.

The voltmeter is available with either of two forms of measuring element. The moving-coil type embodies a fixed and a movable coil, electrically in series; while in the moving-iron type the armature takes the form of a disc, built up of an alloy of high permeability and low losses, lying in the field of a short compact solenoid. In each case the moving part is carried on simple rugged knife-edge springs, one of which is directly connected to the recording pen arm. The moving-coil type is used where a complete scale is required, the graduations gradually widening as the upper ranges are approached. The moving-iron type of element provides a very uniform width of graduation through a limited range, and is particularly suited to calibration with a suppressed zero. The scales obtained with the two classes of voltmeter movements are shown in Fig. 2 as "A" and "B" respectively.

The ammeter movement is structurally similar to that in the moving-iron type of voltmeter, having a relatively long solenoid; and the armature combines a plunger and a disc in such a manner that there is obtained a scale having a remarkable degree of uniformity throughout its range. This scale is shown at "C" in Fig. 2. A micrometer adjustment is available for field calibration of these instruments; and in the voltmeter, fixed circuit conditions are maintained by the use of "Vitrohm"

resistance in series with the movement. The inertia of the moving parts is kept as low as is consistent with the powerful actuating forces; and such damping as is necessary is effected by a vane moving in oil. The design of the oil reservoir facilitates filling, emptying and cleaning. The wide range of damping obtainable with different grades of oil makes it possible to record with precision small variations on comparatively steady loads; while on feeders with widely fluctuating loads the moving system can be overdamped sufficiently to prevent objectionable blurring of the charts. Two classes of pen, the "V" type and the reservoir type, are available, and these are supplied to suit the preference of the individual user.

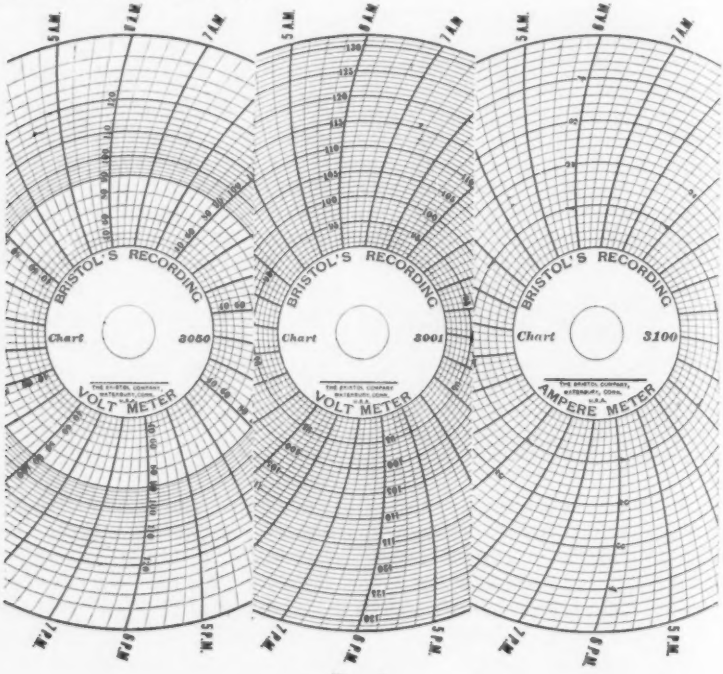


Fig. 2

A. Scale of moving-coil voltmeter. B. Scale of moving-iron voltmeter. C. Scale of ammeter.

By judicious use of the scale ranges shown, in conjunction with the proper instrument transformers, it is possible to secure chart records useful throughout their entire width; and, from the standpoint of those who have the handling of operating records, the circular chart is particularly suited for rapid examination and filing. And with a seven-day chart the whole week's performance is visible at a glance. Regular chart speeds are for 24 hours or for seven days per revolution. The synchronous type of electrically driven clock has given great satisfaction, and has been chosen as standard equipment on these meters; but the spring-driven type can be supplied.

The rectangular case of the instrument consists in a light but sub-

stantial casting having an over-all size of 8 by 10½ inches, 4 inches deep. The hinged door, which exposes the whole interior of the instrument, is so placed that there is no interference between adjacent recorders, if placed side-by-side. Associated with the name-plate is a convenient tag-holder, particularly useful in identifying the circuits upon which the recorders are installed. Throughout the design the feature of interchangeability has been kept in view, and the whole mechanism may readily be removed from the case without disturbing the switchboard mounting or the wiring on the back of the panel. Neatness of design, and carefully selected finishes make the appearance pleasing to the eye.

While numerous applications of a medium sized round chart instrument suggest themselves to the meter engineer and the plant executive, the particular field of this recorder is found in the sub-station whence radiate feeders upon whose individual load characteristics a close check is desired. With a combination embodying on each panel three ammeters and one voltmeter, continuous information is given as to conditions of loading, current balance and voltage regulation with changes in the load. This arrangement which has been widely applied on feeders, both regulated and unregulated, and this, with a seven-day chart, is particularly suited to unattended sub-stations.

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Miniature Portable Precision Instruments

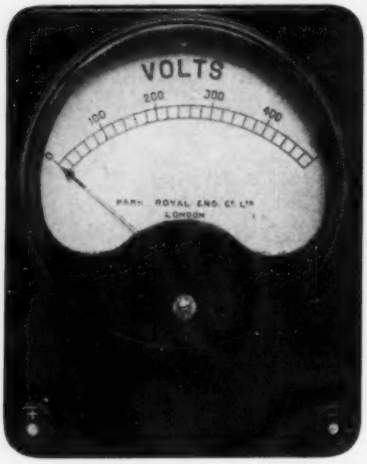
THE PARK ROYAL ENGINEERING CO., LTD., have developed Miniature Portable Precision Instruments, which combine multi-range first grade accuracy with ruggedness, and hence find a great demand among wireless, motor car, telephone and other similar testers.

Three models can be supplied; a voltmeter, an ammeter and a volt-ammeter. The latter instrument is self contained up to 600 volts and 30 amperes, external resistances or shunts being required for the higher ranges. Six ranges can be contained in one instrument, the necessary change-over of connection from amperes to volts being affected by means of a neat switch on the instrument base. The dustproof Bakelite base and sheet iron cover are well finished and give a handsome appearance to the instrument. The adverse effect on the accuracy of the instrument produced by any stray external fields is eliminated by the shielding effect of the sheet iron cover.

The movement itself is constructed on the Duprez and D'arsonval principle, the torque being produced by passing the current through a coil which moves in the concentrated field of a permanent magnet.

The moving coil is fitted top and bottom with the Park Royal Engineering Co.'s Patent Spring Pivots which bear in specially set Ceylon Sapphire jewels. This suspension is known as the "Pivaspring," and has proved itself in practice to be capable of insulating the movement from the ill effects of the most severe shock and vibration. The Gun-

fire test as applied to all British Admiralty work is first tried. The next test is the firm's standard shock test which consists of mounting the instrument on a wooden tray, having one end hinged and the other resting on an eccentric rectangular shaft revolving at about 500 R.P.M. After this test has been applied for 10 minutes and the instrument has received a very severe buffeting, the pointer still returns to zero and the calibration is unaffected. The excellent damping of the instrument, due to the powerful field in which the coil moves and the aluminum former on which the coil is wound, is especially noticed during this test.



Severe electrical tests are also applied at the works before shipping, all instruments being subjected to a flash test of 2000 volts A.C. between any terminal and the case and before calibration a 50% overload in excess of full scale reading is applied for 15 seconds and a momentary overload of 100%.

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Books on Instruments and Devices for Measurement, Inspection and Control

NOTE:—Instruments' Book Shelf is prepared to supply any book or periodical.

GENERAL

A HANDBOOK OF PHYSICS MEASUREMENTS. Erwin S. Ferry and others. Vol. 1. Fundamental Measurements, properties of matter and optics. 1926. 288 pages, $2.50. Vol. II. Vibratory Motion, Sound, Heat, Electricity and Magnetism. 1926. Cloth, 235 pages, $2.00.
MANUAL OF PHYSICAL MEASUREMENTS. A. Zeleny and H. Erikson. 1923. Cloth, 286 pages, $2.25.
THE THEORY OF MEASUREMENT. A Palmer. 1912. Cloth, 248 pages, $3.00.

TEMPERATURE MEASUREMENT

PRACTICAL PYROMETRY. Erwin S. Ferry and Others. 1917. Cloth, 147 pages, $1.50.
METHODS OF MEASURING TEMPERATURE. Ezer Griffiths. 1925. Cloth, 203 pages, $5.00.
PYROMETRY. W. Wood and J. Cork. 1927. Cloth, 207 pages, $3.00.
ELEKTRISCHE TEMPERATUR-MESSGERAETE. G. Keinath. 1923. Cloth, 275 pages, $4.00.
ANLEITUNG ZU GENAUEN TECHNISCHEN TEMPERATUREMESSUNGEN. O. Knoblauch and K. Hencky. 1926. Cloth, 174 pages, $4.00.

A New Electric Engine Indicator and Spark Plug

FOR some time past, the pages of INSTRUMENTS and other technical booklets have carried descriptions and advertisements of the McCollum-Peters electric telemeter pressure transmitter which is a precision electrical instrument of unusual characteristics operating by means of two highly refined carbon resistors.

The pressure to be measured unbalances a Wheatstone bridge circuit which

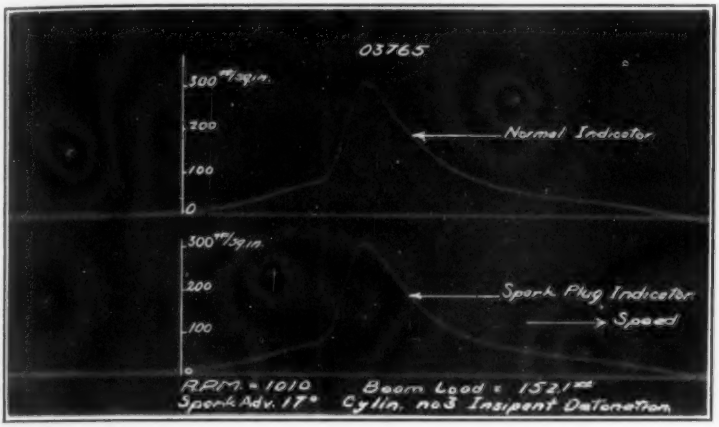

Fig. 1

amount of unbalance can be accurately recorded on an oscillograph or on a recording potentiometer.

During the last several years the General Motors Research Laboratories, using the McCollum-Peters resistors, developed an electric pressure gauge for use in internal combustion engine cylinders to obtain by means of the oscillograph an indicator card similar to that shown in Fig. 1. Their researches in this line were described in the S. A. E. Journal of July 1928, in an article by Dr. E. J. Martin and Mr. D. F. Caris, of the General Motors Research Laboratories entitled "A New Electrical Engine Indicator," which article aroused considerable interest and comment.

The next step in their laboratory was a combination indicator and spark plug so that the pressure transmitter could be screwed directly into the spark plug opening of an automobile engine. This was finally developed in a most satisfactory manner, as shown in Fig. 2, which shows the carbon resistor pressure transmitter and spark plug in one unit.

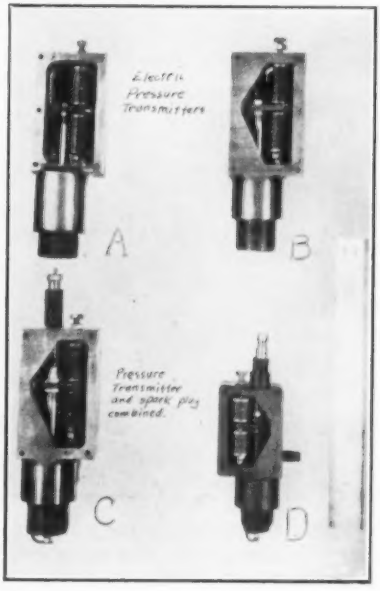

Fig. 2

This combination makes it unnecessary to have an extra opening in the cylinder head.

This equipment is now manufactured under license from the General Motors Corporation by Southwark Foundry & Machine Company and can be used in connection with any commercial make of oscillograph which has current and frequency characteristics to meet requirements. It has also been used in connection with the Cathode Ray Oscillograph which is a very simple, portable apparatus which gives a visual picture of the standing wave.

The indicator card is viewed on a fluorescent screen at the end of the Cathode Ray tube. This is also described in the aforementioned article in the S. A. E. Journal.

This engine indicating equipment has several features which have made it most useful in automotive engine development and design as well as in the study of fuels and it offers possibilities for further scientific studies in this field.

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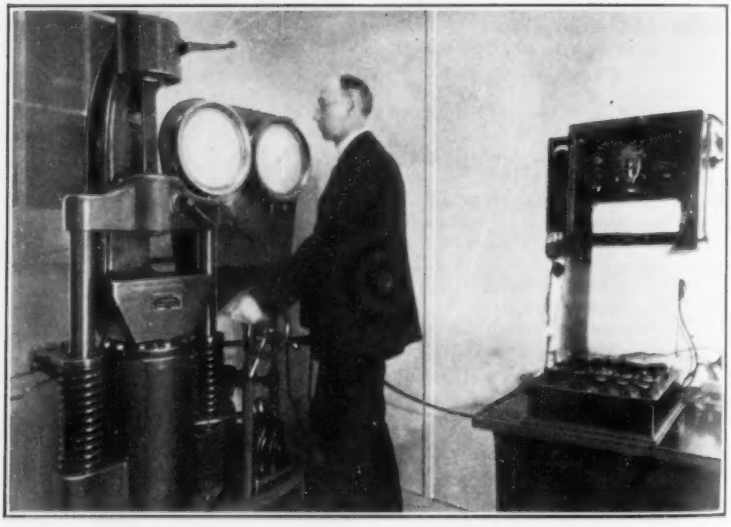
A Demonstration of Physical Testing and Recording

SOUTHWARK FOUNDRY & MACHINE COMPANY have established at their plant an operating exhibit of the newest forms of hydraulic testing machines and recording apparatus.

Two separate recording systems are being shown, one developed jointly with the Brown Instrument Company and one with Leeds and Northrup Company. This latter is an electrical multiple range recorder with many unusual characteristics and is shown in the illustration.



The human element is entirely eliminated by these methods of recording so that unbiased comparisons of materials over a long period of time may be made.

The laboratory is an outgrowth of this plant's own testing program and is also a demonstration of the Company's products in the testing equipment field.

New Meter Service Breaker

THE Westinghouse Electric and Manufacturing Company announces the development of a positive automatic circuit breaker in the WK-50 meter service breaker. This new breaker is safer than fuses because its performance cannot be easily altered by adverse conditions. It not only protects the electric service companies' equipment, but it also protects the customer. Because of its longer time element, it withstands temporary overloads, but it will open the line before any damage can be done to the equipment or to the insulation of the conductors. This feature makes the meter switch particularly adaptable for domestic use because it allows for excessive starting currents of motor driven household appliances.

The service breaker is operated by a toggle switch being quick make and quick break, thus eliminating contact burning and variable action. It is operated from the front by an improved and perfectly insulated handle, which can be locked or sealed into the off position if desired. The box is of the usual form and dimensions, with arrangements made for ordinary meter trims and banking troughs.

Since there is no need to have access to the circuit breaker mechanism, it is sealed inside an insulating cover. This feature prevents tampering and helps in keeping out dust and dirt. External connections make it unnecessary to disturb the circuit breaker and facilitate wiring. All parts are cadmium plated to reduce corrosion or of non-corrosive material to prevent moving parts from corroding together. Every precaution has been taken to assure that the breaker is always in good operating condition.

The self-heating bi-metal, operating the latch on the breaker, will not fuse on any overload current that can be obtained at the rated voltage. In case of mechanical failure this U-shaped bi-metal acts in the circuit as a link fuse and opens the circuit without injury to other parts of the breaker.

Four valuable features are inherent in this meter service breaker. It eliminates the tampering with fuses. It protects the customer from the hazards encountered when replacing blown fuses. Service calls by the operating companies are eliminated as the customer can reset the breaker thus decreasing the service expense to the Central Station. It has con-

siderable time element which permits the starting of domestic motors without tripping out.

The WK-50 service breaker is for 30 ampere, 125 volts, 2 wire, solid neutral service. The breaker has been accepted by the Underwriters' Laboratories and bears their label as a device approved for entrance use as required by the National Electrical Code.

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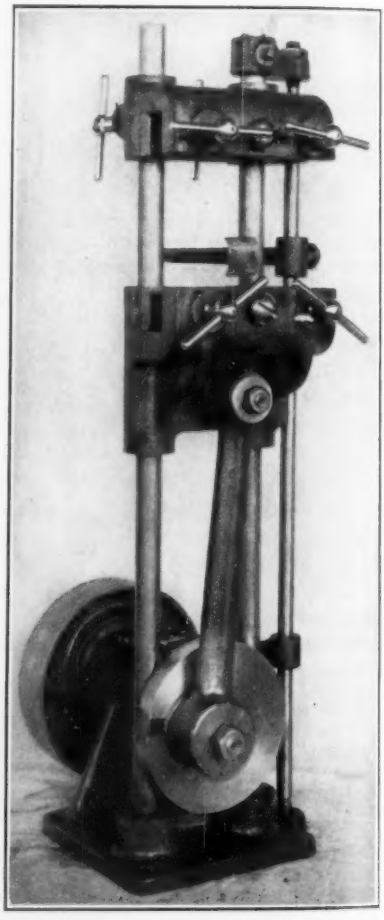
Rubber Fatigue Testing Machine

National Rubber Machinery Co.

TEST pieces of cured rubber or elastic compounded material of conventional sizes are tested for elongation, tensile or flexing strength by the simple operation of extending and releasing it continuously and at predetermined speed, to the point of breaking.



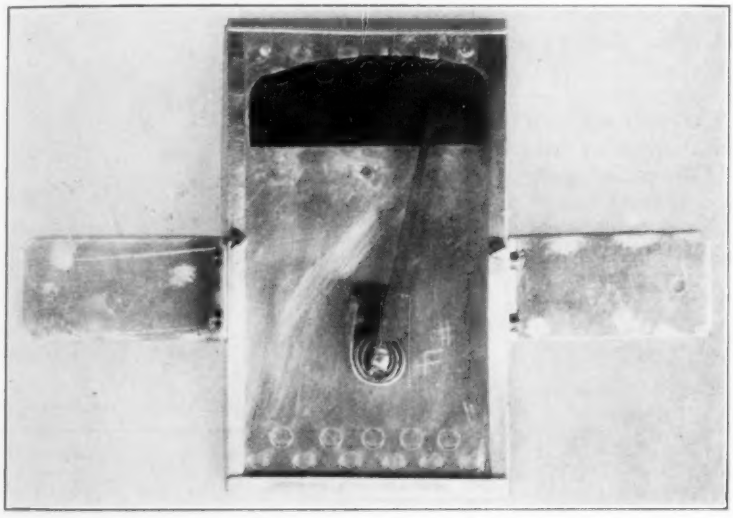
The machine is designed for quick change of the elongation travel, and rapid sure grip of jaws. A valuable feature of the machine consists in the possibility of checking the degree of vulcanization between a test piece cut from a regular product and a like piece cured in a test or sample mold.

Attachments for this machine to allow a compression test of two pieces of rubber compressed together or against a surface at any degree of movement in as much as the stroke goes down to absolute zero have also been developed. Another attachment allows two pieces of rubber to be inserted in a special device for making a twisting test. There are many applications of such fatigue tests that can be made, and it is applicable to manufacturers of all classes of rubber goods, which require resistance from bending, cracking, frictional and heat-resisting operations.

Minimum Temperature Recording Strut Thermometer**

*H. B. Henrickson**

THIS recording strut thermometer is a simple instrument for use in aircraft for the purpose of obtaining a record of the minimum temperature only, of the free air through which the plane is flying. It is small in size, easy to attach to the strut, light in weight, and responds quickly to changes in temperature. The time lag is low, amounting to 10 seconds in a wind-stream of 17 m.p.h. At flying speeds this lag would be reduced to approximately 5 seconds. The record is made on a removable camphor-smoked plate by a pen arm attached to a coiled bimetallic strip which is securely mounted on the aluminum frame of the instrument. The coiled strip is made of invar-steel and brass. An arc-like trace



is made on the smoked plate. Graduations have been etched on the base plate near the end of the pen arm so that it is possible to note immediately at the end of a flight the minimum temperature attained. The range of the thermometer is from +100° C. to —100° C. The readings are accurate to ±2 or 3° C. over a range of +40° C. to —60° C. The transparent cover of the instrument is made of heavy celluloid, bent over and secured to a stream-lined form. The celluloid is perforated at the leading and trailing edges in order to allow the air stream to effectively ventilate the bimetal temperature element. The instrument has been used in connection with high altitude flights made by Captains Streett and

*Assistant Physicist, Bureau of Standards.
**Publication approved by the Director of the Bureau of Standards of the U.S. Department of Commerce.

Stevens, U.S.A., and more recently by Lieut. Apollo Soucek, U.S.N. at the times of breaking the landplane and the seaplane altitude records. The instrument on all occasions functioned perfectly and held to its original calibration.

New Model J Micrometers

(Sensitive Research Instrument Corporation)

RADIO lamp tube manufacturers have had to keep a large number of spare instruments in stock to replace instruments burned out when inspecting for grid plate shorts.

This difficulty has been overcome by the new Model J microammeter. This instrument is protected by a fuse and a compensated shunt safety key. When the key is up, the instrument is a 250 volt voltmeter; and any shorts will only cause a deflection of the needle. If no reading is shown when inspecting a tube, the key is depressed and the meter then becomes a microammeter, reading from 0-15 microamperes.

The push button switch is of special design so that it cannot be held down continuously by placing a weight on it.

The instrument is rugged, compact and exceptionally sensitive; it is 6 inches long, 4½ inches wide and 2 inches deep.

The scale is calibrated and hand drawn having an unusual length of 3¼ inches. The damping is so arranged that the pointer just passes its final position before coming to rest.

The top is a highly polished moulded bakelite panel, having a zero set and locking key. The case is walnut and dust proof.

Normally, it is equipped with binding posts on the top surface of the panel as illustrated, but the instrument can be supplied for flush mounting into a panel or table, binding posts in back or on bottom of the case.

RANGES AVAILABLE

Single Range d. c. Full Scale Microamperes	*Double Range d. c. Full Scale Microamperes*	*Triple Range d. c. Full Scale Microamperes*
3	5-50	5- 50-500
5	10-100	5- 25-100
10	15-30	10-100-1000
15	20-200	20-100-200
20	50-500	20-200-2000
50	200-2000	
100		
120		
200		
240		

A New Automatic Signal Lamp

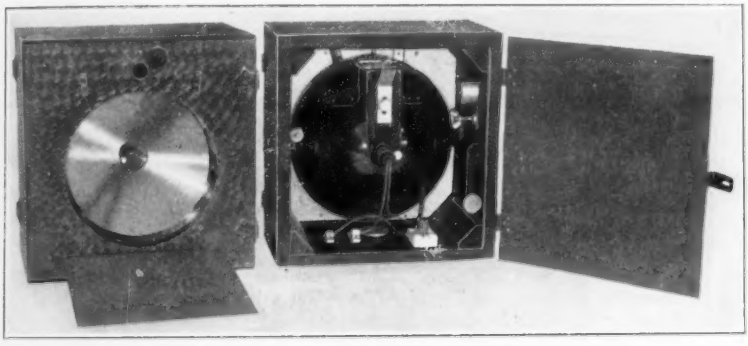
(*American Instrument Company*)

THE problem of measuring the angles of a triangle, with the precision required for the location of control stations upon which coastal charts and topographical maps are based, is beset with a number of difficulties.

For first-order triangulation, the United States Coast and Geodetic Survey has set a limit of three seconds of arc as the maximum allowable of closure of any triangle, and a limit of about one second for the average closure of all triangles in an arc, after curvature of the earth has been taken into consideration.

Other errors than those due to instrumental equipment have also to be guarded against. The bending of the light rays, due to currents of heated air, is an important factor and, when the reconnaissance, or selection of stations, is made, care is taken that no line of sight shall pass close to heated smokestacks, buildings, or to sloping hillsides. Currents of heated air also cause the point under observation to appear to dance about, rendering accurate pointing difficult and, consequently, all first-order observations are made at night when atmospheric conditions are better than during the greater part of the day.

For such night observations, artificial lights must be placed at the points to be observed upon, and various types of signal lamps have been used in the past. In some of the earliest lamps, the source of light was a burning magnesium ribbon, fed from a magazine by clockwork. Student kerosene lamps, bicycle lamps and acetylene automobile headlights were also tried. These types of lamps have all been superseded in the Coast and Geodetic Survey by electric signal lights, which are more convenient, more reliable, and easier to operate. The important requisites of such a signal outfit are reliability, power, portability, simplicity and low cost.



In use, the signal lamp is carried to the point upon which it has been decided to make observations, the point being so located that it can be observed upon from all other stations of the triangulation net.

A wooden stand is erected at the point to be observed upon and the lamp mounted upon it, directed towards the station at which the theodolite is located.

The reflector projects the rays with a remarkably small divergence, usually less than 4 degrees, when used in conjunction with the special bulb which is described later. Lugs attached to the sides of the reflector serve as a bearing for pivots upon which the reflector can be titled through approximately 20 degrees. A slow-motion screw aids in pointing. A telescoping peep-sight is mounted on top of the reflector and is adjustable so that it can be directed along the exact axis of the rays.

A switch is provided in the base of the lamp, which serves both to cut off the current and as a telegraph key, communication between signalman and observer being effected in code by flashes of light. This is a valuable feature of the electric type of signal lamp, as instructions and other information can readily be

transmitted between the parties, thus avoiding much unproductive traveling, and speeding up operations.

The 3.7-volt bulb used is of a special type, in which the filament is concentrated into a small helical coil, furnishing a powerful but diminutive source of light. This type of filament is easier to focus and, as it is concentrated at the focal point, the divergence of the rays is less than with the usual type. The beam is very powerful, having been seen from a distance of 100 miles, using a telescope of moderate power.

This lamp, using a 6-volt bulb, has been observed upon over a line a hundred and fifty-two miles in length. This exceptionally long line was over a dry country where no interference was experienced from haze.

By the introduction of a clock-operated automatic lighting device which will light the lamp at a predetermined hour each evening, the cost of attendance can be very materially reduced. Except in unusual instances, one attendant, furnished with a motor truck, can care for a number of lights even though they are many miles apart.

The automatic lighter is made up of a special switching mechanism designed by the Coast and Geodetic Survey, and a standard eight-day clock—the time shaft of which revolves once each twenty-four hours—mounted in a standard, pressed-steel box arranged to hold the necessary number of dry cells. A cable outlet is provided in the side of the box, so that no extra protection is needed from the weather.

The battery used depends upon the intensity of the light required, which varies according to the length of the line and the visibility. Ordinarily, six No. 6 dry cells, connected three in series, two sets in parallel, are used. Such a battery will light a lamp six hours a day for about three weeks.

The entire signal outfit, consisting of one lamp and one lighter, without battery, weighs but 18½ pounds.

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NEW INSTRUMENT INFORMATION FORM

INSTRUMENTS—*Industrial and Scientific*
1117 Wolfendale St., Pittsburgh, Pennsylvania

Please furnish additional information on the following checked items:

- ☐ James Brake Inspection Decelerometer
- ☐ New Model 547 Radio Set Tester
- ☐ New Tachometer Generator
- ☐ Substation Switchboard Circular-Chart Recorder
- ☐ Miniature Portable Precision Instruments
- ☐ New Electric Engine Indicator and Spark Plug
- ☐ A Demonstration of Physical Testing and Recording
- ☐ New Meter Service Breaker
- ☐ Rubber Fatigue Testing Machine
- ☐ Minimum Temperature Recording Strut Thermometer
- ☐ New Model J Microammeters
- ☐ New Automatic Signal Lamp
- ☐ Stiffness Tester for Paper Light Cardboard, etc.
- ☐ Portable Lightning Generator for Field Testing

NAME_____

STREET_____ CITY & STATE_____

COMPANY_____

POSITION_____

Stiffness Test for Paper, Light Cardboard, Foils and Membranes

(*Askania-Werke A. G.*)

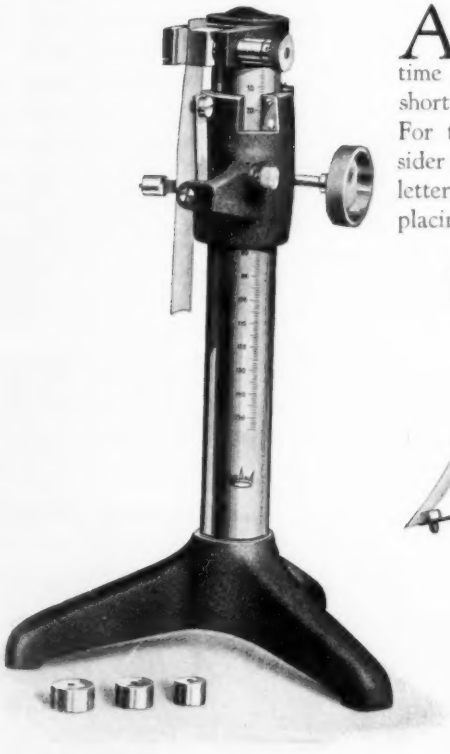

Fig. 1

AS the conception of stiffness arises for the first time with this instrument, a short definition is permissible. For this purpose we will consider the possibility of reading letters and newspapers without placing them on a support. In most cases they are held at an angle of less than 45 degrees to the horizontal, and in fact so that a slight curvature is present due to the grip of the hand. This curvature counteracts the effect of gravity, which attempts to pull down the top part of the sheet. If too great a length of the paper is held horizontal, the sheet is creased downward. The same occurs if a spot in the paper is loaded with too great a weight. The length, as also the weight added, is therefore a numerical measure of the stiffness. As one cannot vary the

Fig. 2

length at will, it remains that for a wholly satisfactory solution, the numerical determination of the stiffness be made by means of weights.

The new stiffness tester (see Fig. 1) operates as follows:

A strip of the paper, to be investigated, is cut into strips 2 cm wide and 5-15 cm long, according to what is available. This is clamped in the spring jaws at the top of the instrument so that a curvature is obtained. The arresting screw is released, and the weight acts on the hollow side of the paper strip, by means of a lever mechanism. The length of sample tested can be varied by moving the slide carrying the weight by means of a rack and pinion. If the paper is too short so that a sideward creasing is not possible, a heavier weight must be used. With a certain distance, of the slide carrying the weight, creasing results, as is illustrated in Fig. 2. The distance of the point of application of the force from the clamping point can be read on a scale to 1/10 mm by means of a vernier and gives a measure of the stiffness of the particular sample.

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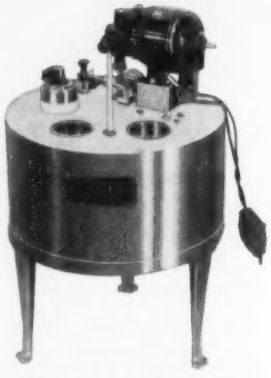
Time and money can be saved by reading Instruments' Advertising Pages as often as its editorial pages. That is because all advertising in INSTRUMENTS is vouched for by the company whose name is on the advertisement.

American Two-Tube Constant Temperature Viscosimeter Replaced Six of the Regular Type

with one oil company.

This bath will assure a saving of $2.00 to $5.00 per viscosity determination in comparison with the older equipment.

Also — the temperature of the bath is automatically controlled to within 0.1° F., which is rarely possible with the equipment formerly used.



For additional information write

THE AMERICAN INSTRUMENT COMPANY

774 Girard Street, N.W. **Washington, D. C.**

When writing to the American Instrument Company, mention INSTRUMENTS

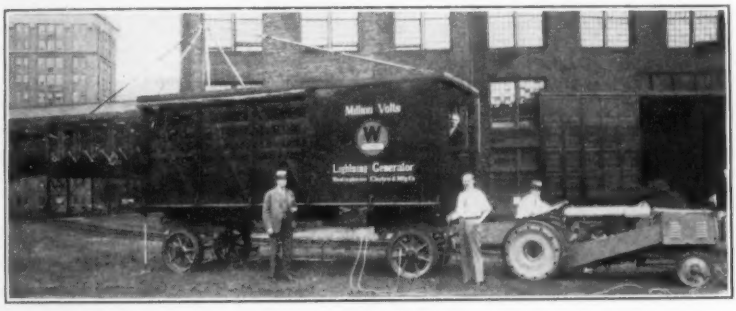
Portable Lightning Generator For Field Testing

(Westinghouse Electric & Manufacturing Co.)

ELECTRICITY and its use for domestic and industrial purposes have been growing rapidly and along with this increase in the extent of its use, there has been an increase in the importance of continuity of electric service. One of the major causes for interruption to service, one that is yielding most reluctantly to the forces of scientific investigation and analysis, is lightning and its effect on transmission lines, the real arteries of power.

The Westinghouse Electric and Manufacturing Company, in cooperation with the local public utility serving the district wherever an installation is made, has set up several lightning investigation stations in the field during the past two years and are making headway in the study of this problem. Progress is also being made in types of equipment used at these stations. Instruments and apparatus have been developed capable of recording voltages and behavior of lightning surges on transmission lines. The most notable instrument of this kind is the Norinder type of cathode-ray oscillograph employing the electron jet principle. At one of the latest installations, in addition to equipment for recording such important data, apparatus will be used for simulating lightning, really manufacturing lightning, and, in this way, much more extensive data will be secured.

This rather unusual piece of apparatus is known as a lightning generator and is capable of impressing surges of more than a million volts on a transmission line. The method employed for generating such high voltages is fundamentally the same as that used in the high-voltage laboratory of the Westinghouse Company. Units of several condensers each are charged in parallel at a relatively low voltage. These are then discharged through a circuit arranged so that, at the time of discharge, the voltage of each condenser is in an additive relation to all the rest, and the resulting voltage generated is the sum of the voltages of the individual condensers.



At this modern lightning experimental station, a radical departure from conventional practice has been taken, namely, both the instruments for recording the surges and the equipment for manufacturing the surges have been made portable, and are, therefore, quite flexible in their application. The lightning surge generator itself is housed in a four-wheel trailer having the generator appearance of a single-room cabin with a roof very slightly peaked. The house is 20 feet long, 8 feet wide and 7 feet high.

The difficult task of building a portable generator, suitably arranged to provide the proper insulation against such extremely high voltages in order that they might be controlled and usefully applied to a testing circuit, has been accomplished by using quite a novel feature in its design. This feature is one of suspending the condensers and that part of the circuit that will be raised to a million volts from a beam or bridge fabricated from insulating material, micarta and maple wood. Such a beam is necessarily quite long but the outfit has been given the desired portability by using a collapsible bridge. When the set is ready for oper-

ation, the bridge is extended to twice its length, half being inside the house and half outside in the air, thus providing ample separation and insulation from ground.

The bridge extension is 14 feet long and carries a weight of 1½ tons. It is therefore necessary to support it at a point near the outer end. This is effected by two wood strain insulators, each 5 feet long, end-to-end fastened to the bridge at a point about 9 feet out. To the other end of the insulators is fixed a steel cable which is passed over a pulley 5 feet above the near end of the house and is anchored near the far end of the house. The tension on this cable is 4000 pounds. The bridge is 3½ feet wide and to each side of it is attached a grooved track on which seven units of condensers are rolled out.

Each of these units, fourteen in all, consist of 5 cans of condensers, each having .5 microfarads capacity and occupying a space approximately 3½ ft. x 1½ ft. x 1⅓ ft. Each unit is suitably suspended from its micarta carriage two feet below the bridge. When set up ready for test, seven of these units are located on the extension and seven units are on the portion of the track inside of the house located near the roof. On the outer end of the bridge is located the high-tension insulator, from which the million volt lead wire is suspended when connected to the transmission line, the sphere gap that serves as a switch in the sense that, when it breaks over, the generator is electrically connected to the line, and variable reactance used for shaping the waves into one of the many possible forms which will be used.

In the end of the house away from the bridge are the step-up transformers used to raise the a.c. voltage up to the thousands of volts required by the rectifying tubes, the two high voltage rectifying tubes that change the alternating current into direct current needed to charge the condensers, insulating transformers, several voltmeters and ammeters, and the control switches. The low voltage is supplied to the step-up transformers from a generator mounted in the front of a Fordson tractor, the frame of which has been altered by lengthening to afford space for the generator. The tractor drives the generator, through a belt connection, and also provides the motive power for drawing the trailer that houses the lightning generator.

The trailer has four wheels. The two wheels on each end can be pivoted or locked in mid position, in this way to pull in either direction is made possible. The top of the floor of the house is 50 inches above the ground; the peak of the roof is 11¼ feet above the ground, and the top of the pulley in the superstructure is 16½ feet above the ground. The total weight of the surge-generating equipment is three tons. The gross weight of the trailer is 10½ tons.

The method of generating the million volts is briefly as follows: Each of the 14 units of five condensers is charged to 75,000 volts. All of the units with the accompanying resistances are connected in parallel for charging. Then an end unit is allowed to discharge across its individual spark gap in series with 100,000 ohms resistance. This discharge raises the voltage on the next unit sufficiently to cause it to discharge across its individual gap similarly to the first; and so all the gaps are broken down in succession. When this has taken place, all condensers are discharging in series and the voltage across each condenser is in an additive relation to all the rest and the sum of the individual voltages of all condensers is the total voltage impressed across the main sphere gap. When the main sphere gap breaks down, the entire million volts is impressed on the transmission line.

Ordinarily, two men will be assigned to the operation of the generator. These men are only one-third of the entire testing crew on the transmission line. The others are used at the cathode ray oscillograph station which is also portable in this case. It requires about five hours for the two men to set up the lightning generator from the "assembled for shipping" condition.

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AIRPORT LIGHTING. This booklet, No. S. P. 1854, contains the lighting requirements of the U. S. Dept. of Commerce, including the candlepower for beacons, wattage for boundary lights, obstruction light requirements, and the location and intensity of illumination of floodlights and ceiling projectors. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

AERONAUTICAL ALTIMETERS. Section V, 1929 Catalog, discusses the use of the Paulin System Altimeter on Aircraft. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

ALTIMETERS. Section III, 1929 Catalog, illustrates the following types: A-1, The Surveyor; A-2, The Engineer, and A-3, The Explorer. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

ALTIMETRY MANUAL. The booklet is a treatise on the various uses of Paulin System Altimeters. The instrument is described. Its use in various preliminary surveys and field investigations is taken up, also the determination of altitude and special instructions. Correction tables are included for change in air density due to change in temperature. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

AMPEREHOUR METERS. Bulletin No. 78 gives detailed information on Type N Amperehour Meters. Sangamo Electric Company, Springfield, Ill.

BAKELITE REVIEW. Vol. 1, No. 2, July 1929 issue illustrates a number of applications of Bakelite. Bakelite Corporation, 247 Park Ave., New York, N. Y.

BALANCING WAY. Leaflet describes briefly a portable balancing way. N. P. Bowsher Co., South Bend, Ind.

BAROMETERS. Section IV, 1929 Catalog, illustrates several models of barometers. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

CHEMIST ANALYST. The July 1st issue of this periodical contains a number of analysis methods and laboratory suggestions. J. T. Baker Chemical Co., Phillipsburg, N. J.

DESCRIPTION AND USE OF PAULIN AERIAL ALTIMETER AND FLIGHT LEVEL INDICATOR. The leaflet discusses the following: Adjusting altimeter to take-off elevation; Flying in obscure weather; Landing under adverse conditions. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

ENGINE COMPRESSION INDICATOR. Leaflet illustrates compression gauge. G. L. Holzapfel, 1704 Post-Dispatch Bldg., Houston, Texas.

FIXED INDUCTANCE STANDARDS. Circular 1530-60-11-25, illustrates self inductance standards with no appreciable increase in resistance at audio frequencies. Leeds & Northrup, 4901 Stenton Ave., Philadelphia, Pa.

FLOW METER. This 90 page catalogue contains a complete presentation of the general theory, use, design and practical application of the flow meter; with a detailed, illustrated description of the principle, construction and features of the Brown electric flow meter. Catalogue No. 21. Brown Instrument Co., 4482 Wayne St., Philadelphia, Pa.

EXPERIENCES AND ADVANCES IN BUILDING HIGH TENSION CABLE TESTERS. This 34-page booklet furnishes information on this subject. This is printed in German. Booklet No. S.H. 2772. Siemens & Halske, A. G., Berlin—Siemensstadt, Germany.

GAS SERVICE JOURNAL. The July issue of this periodical contains the following articles: High Pressure Gas Distribution Principle as Developed by Public Service in New Jersey field; Emco "Emco" Low Pressure Regulators Form Novel and Useful Part of Natural Gas Distribution System; Early Developments of Orifice Meter Measurements; Problems of the Gas Industry. Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa.

GENERAL CATALOGUE. This 32-page booklet briefly illustrates and describes the products manufactured by Lehmann & Michels, Hamburg—Altona, Abt. I, Germany.

GENERAL RADIO EXPERIMENTER. The June issue of the Experimenter contains the following articles: Production Testing of Audio-Frequency Amplifiers; New Testing Instruments for the Radio Service Laboratory; Direct Current Amplifier Design. General Radio Company, Cambridge, Mass.

GROUNDOMETERS. Type D groundometer is described in Bulletin No. 110. Other points taken up in this literature are: Measurements; "Live" Grounds, Earth Currents, Test Leads and Electrodes, Limitations of Measurements, True Economy in Ground Testing. Borden Electric Co., 480 Broad St., Newark, N. J.

HEAT ECONOMY IN THE GAS PLANT. This is the title of a 48-page booklet. The various instruments for gas plant use are included. Bulletin S.H. 2958 is printed in German. Siemens & Halske, A. G., Berlin—Siemensstadt, Germany.

HEAT ECONOMY IN COKE OVEN OPERATION. S.H. 2997 is an 18-page booklet which discusses the application of instruments to the coke oven plant. This is printed in German. Siemens & Halske, A. G., Berlin—Siemensstadt, Germany.

IMPEDANCE PROTECTION FOR CABLES AND WIRES. Bulletin S.H. 2776 is a reprint of an article appearing in the November 1928 Siemens-Zeitschrift. Impedance protection is discussed and the relays used are shown. Siemens & Halske, A. G., Berlin—Siemensstadt, Germany.

INDUSTRIAL THERMOMETERS. Catalog No. 200 illustrates industrial indicating thermometers for all industries. The Palmer Co., Cincinnati (St. Bernard), Ohio.

INDUSTRY'S MOST RELIABLE PYROMETER. B-6-P 400-529 covers the potentiometer pyrometer for industrial temperature control. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

INSTRUMENT INVESTMENT NEWS. The July issue of this publication contains the following articles: Kraut Flavor Depends on Proper Cooking; High Pressures and Temperatures Require Finest Accessories; Temperature Control the Basis of Successful Chromium Plating; Railroad Air Brakes Tested for Safety; Bleaching Textiles a Thermal Operation. Consolidated Ashcroft Hancock Co., Inc., 11 Elias St., Bridgeport, Conn.

LOSSES IN BOILER FURNACES DUE TO INCOMPLETE COMBUSTION. This is a reprint of an article on this subject appearing in the periodical "Die Waerme," 8 pages. Printed in German. Siemens & Halske, A. G., Berlin—Siemensstadt, Germany.

METHODS FOR THE MOST ACCURATE MEASUREMENT OF OPERATING FREQUENCIES. Printed in German. Reprint of an article from the December 1928 issue of the Siemens-Zeitschrift, 14 pages. Siemens & Halske, A. G., Berlin—Siemensstadt, Germany.

MICROGRAPHIC APPARATUS. Leaflet M13 covers a small vertical and horizontal photo-micrographic apparatus. C. Baker, 244 High Holborn, London, England.

NEW DEVELOPMENTS. This 67-page bulletin covers the developments made during the thirty months ending December 31, 1928. Adam Hilger, Ltd., 24 Rochester Place, London, N.W.1, England.

OPTICAL PYROMETER. Bulletin S.H. 2809 gives a description of the disappearing filament pyrometer and its application. It also describes the micropyrometer for reading the temperature for small objects as lamp filaments; the teleobjective, an attachment for the optical pyrometer when reading the temperature of objects at a distance and a total reflecting prism for reading the temperature in vertical tube furnaces. Siemens & Halske, A. G., Berlin—Siemesstadt, Germany.

PHOTOMICROGRAPHIC APPARATUS. Leaflet M9 describes a universal geometric slide photomicrographic apparatus. C. Baker, 244 High Holborn, London, England.

PI-METER. This leaflet describes an instrument for indicating the mean indicated piston-pressure of internal combustion engines. Lehmann & Michels, Hamburg-Altoona, Abt. I, Germany.

PRECISION-RESISTANCE AND MEASURING BRIDGES. This 16-page booklet describes the construction of precision resistances and measuring bridges. S.H. 2523. This is printed in German. Siemens & Halske, A. G., Berlin—Siemensstadt, Germany.

PROFILE MEASURING MACHINE. Equipment for the measurement of the form and shape of screw threads is described in this 16-page booklet. G. Cussons, Ltd., Lower Broughton, Manchester, England.

RADIO SET TESTER. This leaflet covers the Model 547 radio set tester. Weston Electrical Instrument Corp., Newark, N. J.

RECENT DEVELOPMENTS IN AUTOMATIC NETWORK PROTECTORS AND RELAYS. The material included in this booklet consists of revised reprints from the "Electric Journal" and a list of distinctive features of the CM-2 network protector. Various photos and circuit diagrams point out the application and features of these units while charts are used to supplement the technical discussions. Circular 1837. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

GAS SERVICE JOURNAL. The August issue of the journal contains the following: First Gas Company in America Established at Baltimore; Some Early Gas Holders; Problems of the Gas Industry No. IV, The Penny-Wise Pound-Foolish Policy; The Air Liner. Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa.

HAVE COSTS REACHED BOTTOM IN YOUR PLANT? Leaflet discusses method of studying costs by means of graphic records. Esterline-Angus Co., Indianapolis, Ind.

KNOWN FACTORS IN METER VALUE. This is the title of General Catalogue G-1. It covers: gas meters for domestic and industrial requirements; meters for demonstration, demand, etc.; meters for large volume measurement; and laboratory, experimental and service apparatus. American Meter Company, 10[illegible] W. 40th St., New York, N. Y.

ACCURATE SCREW PITCH MEASUREMENT. A 16-page booklet describes screw pitch measuring machines for testing the accuracy of pitch of screw gauges, bolts and nuts, or taps and dies. G. Cussons, Ltd., Manchester, England.

ELECTRICALLY HEATED LABORATORY APPARATUS. This literature illustrates hot plates, thermometer calibration tanks, heating furnaces, melting furnaces, etc. Leaflet TA-23. Harold E. Trent Co., 439 North 12th St., Philadelphia, Pa.

REGISTERS OF REVENUE is the title of a booklet released by the Westinghouse Electric and Manufacturing Company. A short discussion of the origin and history of watthour meters is included. The requisites of a good watthour meter and its construction are explained. The need of subdivided metering is discussed with the aid of charts. OB meters, portable meters, and remote control meters with equipment are among those described. Illustrations, showing construction of the various meters, are also included. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

RICARDO VARIABLE COMPRESSION ENGINES are described in a 20-page leaflet. The engine is designed for general research work on internal combustion engine problems. G. Cussons, Ltd., Manchester, England.

REVISED PRICE LIST. Price list covering surveying and drawing instruments and supplies is dated July 1929. W. F. Stanley & Co., Ltd., 13 Railway Approach, London Bridge, S.E., England.

TEMPERATURE MEASUREMENT IN THE GLASS INDUSTRY. Booklet S.H. 2653 is a reprint of an article appearing in the publication "Sprechsaal," 1928. It is printed in German. Siemens & Halske, A. G., Berlin—Siemensstadt, Germany.

THEODOLITES. Several types of theodolites are illustrated in this 8-page leaflet. Dennert & Pape, Altona—Elbe, Germany.

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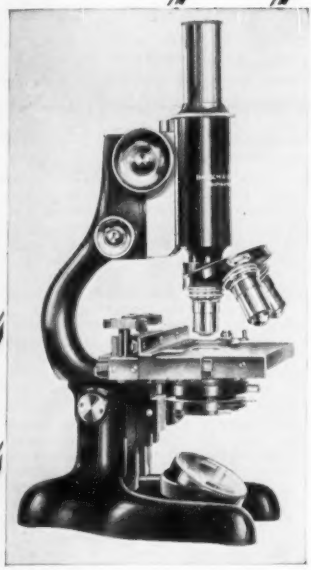

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CURRENT LITERATURE REVIEW

Abstracts on instruments and devices for measurement, inspection and control.

The Technology Department, Carnegie Library, Pittsburgh, Pa., will furnish photostats of material abstracted here. Negative prints are 35 cents per page, plus 10 cents for mailing (first class). All orders should be paid in advance. The library is not responsible for loss in mails.

Some Problems in Dielectric Loss Measurements. C. L. Dawes, F. L. Hoover, H. Reichard. Jl. A.I.E.E., June 1929, pp. 450-453.

The measurement of dielectric loss in high-voltage cables presents many problems which are not simple, and their solution is obtained only after considerable effort and research. This paper presents some of the problems that the authors have encountered in this type of work, together with the methods used for their solution. The bridge method which is used for the measurement of dielectric loss, is described in some detail. Details of the auxiliary equipment, such as galvanometer, amplifier, air condenser, shielding and special methods of bringing the shielding to the proper potential are also given. If accurate results are to be had in dielectric-loss measurements, the entire bridge, including castle, air condenser, and leads must be properly shielded, and the capacitance between leads and shielding should be made small. It is entirely insufficient to shield the bridge and ground the shielding directly. At times, shielding cables may increase the measured losses. In measuring the capacitance of the air condenser, all stray capacitance to its guard rings and to surroundings must be eliminated. The voltage across the voltmeter coil of a high-voltage transformer is frequently taken as a measure of the voltage across its secondary. In some methods of measurement, this voltmeter-coil circuit is an integral part of the measuring circuits. Methods of measuring the ratio of primary to secondary voltage and the phase angle between them are described, and in the complete paper considerable quantitative data are given for typical testing transformers under various conditions of load. The accuracy of the bridge as a power-measuring device may be determined by inserting known resistances into its arms and comparing computed results with observed results. Due to unsuspected leakage and stray-capacitance currents, however, the introduction of such resistances may cause large errors. Methods of minimizing such currents are given, as are analyses of proper and improper methods of making such measurements and observed data and results. Harmonics probably do not introduce error in this type of measurement, but at times they are troublesome in that they produce anomalous effects in the measuring apparatus.

Precautions Against Stray-Field Errors in Measurements with Large Alternating Currents. F. Silsbee. Jl. A.I.E.E., June 1929, pp. 447-450.

In electric power stations it is often necessary to make accurate measurements of current or power when the instruments are located near to the cables carrying large alternating currents. The magnetic field produced by these currents may constitute a serious source of error in the measurements unless careful precautions are taken to guard against such disturbing effects. This paper summarizes the various principles and methods for detecting and minimizing the errors which may arise from this source. The principal methods are: (1) To so arrange the cables carrying the large currents that they produce as little stray magnetic effect as possible; (2) to use instruments of the shielded or of the astatic type; (3) to repeat readings with the instrument connections reversed; and (4) to avoid all loops in the connecting leads.

Guarding and Shielding for Dielectric Loss. Measurements on Short Lengths of High-Tension Power Cable. E. H. Saulter. Jl. A.I.E.E., June 1929, pp. 444-446.

This paper presents the results of investigations made to explain the wide differences found between dielectric loss measurements made on full-reel lengths of cable and on samples (10 ft. net length) removed from these reels. At least one source of such differences is found in losses occurring at the ends of the cable, these losses being insignificant in the case of the full reel but amounting to as much as 100 per cent of the loss in the normal sample. Methods of determining, controlling and eliminating these end losses are described.

Cathode Ray Oscillograph Study of Artificial Lightning Surges on the Turners Falls Transmission Line. K. B. McEachron and V. E. Goodwin. Jl. A.I.E.E., May 1929, pp. 374-378.

A portable impulse generator delivering 400 kv. has been constructed. A cathode ray oscillograph of the cold cathode type has been so connected that impulses incoming over the transmission line to which it is connected will initiate the oscillograph. The results of studies on a 5.77-mi. section of a 66-kv. line of the Turners Falls Power Company are given. Impulses of definite forms are applied to the line. The theory of traveling waves is being checked experimentally, demonstrating the existence and magnitude of reflections, both for open-ended lines and for lines closed through gaps or a combination of inductance and capacity. A simple description of the theory is given. Some preliminary results are given for attenuation obtained by successive reflections from either end of the line. The reduction of the incoming waves by an oxide film lightning arrester is given, the affected wave in one case having a front of six microseconds and in another case a front of 0.5 microseconds. Further work to be done includes the effect of traveling waves on choke coils, transformers and ground wires. Additional work is to be done to determine the laws governing attenuation.

Description of Seventeenth Century Microscope. C. Becke. Jl. Royal Micro. Soc., June 1929, pp. 143-144.

Instrument briefly described.—M.B.R.

(Current Literature Review Continued on Page 16)

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CURRENT LITERATURE REVIEW

Lightning Studies of Transformers by the Cathode Ray Oscillograph. F. F. Brand and K. K. Palueff. Jl. A.I.E.E., July 1929, pp. 542-546.

Study of transformers has been under way for some time to coordinate the strength of transformers and transmission line under lightning conditions. This study has taken two forms; first, the transient dielectric strength of the line end of the winding, and second, the distribution of transient voltages and therefore the stress caused by them throughout the winding. Theoretical studies and spark-gap tests of transient voltage by distribution in transformer windings have been previously published by the Institute. Since then an extensive study of transient voltage phenomena has been made by the cathode ray oscillograph on power transformers connected to a short transmission line and subject to artificial lightning waves sent along the line. The effects of the transmission line, concentrated inductance, and transformer entrance bushings on traveling waves were studied, as well as the effect of traveling waves of various service conditions in producing internal oscillations in ordinary transformers. A striking agreement between the oscillographic records and theoretical conclusions previously published was found, sufficient to establish beyond any doubt the following conclusions: 1. Very high-voltage oscillations occur throughout the entire winding of even a grounded neutral transformer. 2. Points of the winding near the grounded neutral may rise to 95 per cent of the crest voltage of a very short traveling wave (three microseconds long). 3. Entrance bushings have a negligible effect on the shape of the incoming traveling wave. 4. In case of sudden voltage changes, concentrated inductance in series with the transformer, unless by-passes by a suitable device, causes rise of voltage across the transformer terminals as well as internally in the windings. 5. Arc-over of line insulators by a traveling wave produces severe oscillations in a transformer the amplitudes of which are roughly proportional to the arc-over voltage of the line insulators. 6. Grading the insulation between high voltage and low voltage and ground in ordinary transformers with grounded neutral is a dangerous practice when the transformers are subject to lightning. 7. All the above conclusions apply to concentric winding core type as well as interleaved and shell type transformers. From theoretical studies the non-resonating type of transformer has been developed and its action checked by tests. This type of transformer eliminates voltage oscillation within the winding and therefore local concentration of transient voltage. An Appendix entitled Present Status of the Cathode Ray Oscillograph on the Measurements of Transients, by H. L. Rorden and J. C. Dowell, both of the General Electric Company, Pittsfield, Mass., is included in the complete paper.

Electrical Wave Analyzers for Power and Telephone Systems. R. G. McCurdy and P. W. Blye. Jl. A.I.E.E., June 1929, pp. 461-464.

This paper describes two types of electrical analyzers which have been developed for the direct measurement of harmonic components of voltage and current on power and telephone systems. These devices are assembled mechanically in a form suitable for use in either the laboratory or in the field. Both instruments, which differ chiefly with respect to sensitivity and input circuit arrangement, employ multistage vacuum tube amplifiers and two duplicate interstage selective curcuits. The power circuit analyzer is designed to measure harmonic voltage in the frequency range from 75 to 3000 cycles, and over a voltage range from 0.5 millivolt to 50 volts. The telephone circuit analyzer operates over the same frequency range and measures harmonic currents as low as 0.05 microampere and voltages as small as 0.005 millivolt. Both analyzers are adapted to measure small harmonic voltages and currents in the presence of the fundamental component and other harmonics relatively large in magnitude. A number of devices are described which have been adopted for eliminating various sources of error. The paper presents in detail the characteristics of both instruments with respect to selectivity, sensitivity, linearity, balance of input with respect to ground, generation of harmonics and susceptiveness to stray fields.

Shielding and Guarding Electrical Apparatus—Used in Measurements—General Principles. H. L. Curtis. Jl. A.I.E.E., June 1929, pp. 453-457.

Electrical measuring apparatus is shielded and guarded to protect it from the following external influences; namely, leakage currents, electrostatic fields, magnetic fields, and electromagnetic waves. Apparatus is guarded against leakage currents which may flow over or through the fluid in which the instrument is immersed. By a proper arrangement of guards and shields any apparatus can be completely protected against leakage currents. Any apparatus can be completely shielded from electrostatic fields by placing it in a metallic case. However, there may be electrostatic reactions between the apparatus and shield, thus introducing errors in the measuring apparatus. Shielding apparatus from magnetic fields requires that the apparatus be surrounded by a thick enclosure of magnetic material. The theory of this magnetic shielding has been developed and formulas for producing the most satisfactory shielding are given. The shielding of an apparatus from electromagnetic waves is largely accomplished by means of eddy currents which these waves set up in the shield. The theory for the production of these eddy currents has been developed and the best location of shields is discussed. Some attention is given to the errors which may be introduced by shielding and some methods are outlined for obviating the necessity of shielding.

Measurement of the Dielectric Constants of Liquids, with a Determination of the Dielectric Constant of Benzine. L. Hartshorn and D. Oliver. Proc. Roy. Soc., April 1929, pp. 664-685.

A discussion of the effect of the connecting leads shows that capacity of the leads had never previously been balanced out. A standard condenser was specially designed to avoid measurement of capacity across insulators, and a Wheatstone network of condensers and resistances enabled lead capacity effects to be almost completely eliminated.—Abs. Bull. Kodak Res. Labs.

Dosimetry of the Borderline Rays with the Wintz—Rump Photometer. O. Glasser and I. E. Beasley. Amer. Jl. Roent., April 1929, pp. 407.

For very soft X-rays, the Wintz-Rump photometer is accurate to 10% in intensity measurements, while a small ionization chamber of gold-beater's skin is correct within 5%. (Abstract from Strahlentherapie, 29, 1929, pp. 611-4.) Abs. Bull. Kodak Res. Lab.

(Current Literature Review Continued on Page 18)

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CURRENT LITERATURE REVIEW

Measurement of the Quality and Intensity of Secondary Radiation. H. Jacobi and A. Liechti. Amer. Jl. Roent., April 1929, pp. 410.

Measurements were made on the quality of primary rays after passing through 20 cm. of water, and of the secondary radiation in a water phantom and other materials. Intensity measurements were also made of secondary radiation under various conditions. (Abstract from Strahlentherapie, 27, 1928, pp. 711-27.) Abs. Bull. Kodak Res. Lab.

Condenser Dosimeter and its Use in Measuring Radiation Over a Wide Range of Wave-lengths. O. Glasser, U. V. Portmann and V. B. Seitz, Amer. Jl. Roent., Dec. 1928, pp. 505-513.

A small ionization chamber is combined with a condenser which is surrounded with solid dielectric. The system is charged to a known potential, indicated on the electrometer scale, and is then removed from the electrometer and may be taken anywhere to record a quantity of radiation; it is then returned to the electrometer for determination of the loss in charge. The use of various types of ionization chamber enables this instrument to be used for dosage measurements over a wide range of wave-lengths, from 6 kv. radiation to gamma rays. Abs. Bull. Kodak Res. Lab.

Standards of Measurement and of Protection. Amer. Jl. Roent., 1928, pp. 553-555.

A report of the international unit of X-ray quantity and of the recommendations for X-ray and radium protection adopted by the recent Congress at Stockholm. Abs. Bull Kodak Res. Lab.

Measurement and Specification of Radiant Energy. H. Laurens and H. S. Mayerson. Radiology, Apr. 1929, pp. 328-340.

The authors discuss the nature of the emission spectra of the principal sources used in light therapy, and the absorption spectra of filters used in separating portions of the spectrum. The thermopile is recommended for radiant energy measurements, and its use is described. Other subjects treated are spectroradiometry, spectrography, spectrophotometry, and pyrheliometry. Abs. Bull. Kodak Res. Lab.

Practical Measuring Instrument for Dosage of Ultra-Violet Rays. B. Rajewsky. Radiology, Mar. 1929, pp. 274.

The measuring instrument consists of a cadmium photo-electric cell with quartz window. The photo-electric current is measured with an electrometer or electroscope. (Abstract from Strahlentherapie, 29, 1928, p. 180.) Abs. Bull. Kodak Res. Lab.

New Colorimeter of the Subtractive Type. R. A. Houstoun. British Journal of Radiology, 1928, pp. 426; Kinotechnik, Jan. 5, 1929, pp. 21-22.

An instrument used for measuring color and expressing it in terms of three fundamentals has been made and is at present being tested in the University of Glasgow. The observer, on looking into the eyepiece, sees a circular disk surrounded by the color to be measured. The color of the disk is altered by drawing three gelatin filters across the surface of a lens, until it is the same as the latter. The gelatin filters are in the complementary colors, peacock blue, magenta, and yellow. Special provision is made for dealing with color of higher saturation than can be matched directly. Abs. Bull. Kodak Res. Lab.

Gauging of Roentgen Measurements of Dosage with Radium. H. Behnken and R. Jaeger. Amer. Jl. Roent., April 1929, pp. 399-400.

The definition of a unit of X-ray dosage in terms of a radium standard is at present impractical on account of the effects of many details of instrumental construction. In standard air chambers, radium may be used to check the constancy of sensitivity of the recording apparatus. The use of bakelite for construction of small ionization chambers is discussed. (Abstract from Strahlentherapie, 29, 1928, pp. 483-502.) Abs. Bull Kodak Res. Lab.

Reliability of the R-unit for the Measurement of Roentgen and Radium Radiation. O. Glasser and U. V. Portmann. Radiology, April 1929, pp. 317-327.

Recent comparisons of various types of standard ionization chambers have demonstrated satisfactory agreement in the realization of the R-unit, so that it may now be considered an accurate and reliable dosage unit for use in X-ray and radium therapy. Abs. Bull. Kodak Res. Labs.

Ionization Method of X-ray Measurement. J. A. Crowther, British Journal of Radiology, April 1929, pp. 175-187.

The basic factors in the ionization method of measuring X-ray intensity are reviewed. Energy measurements indicate that in a standard ionization chamber, ionization is proportional to the absorbed energy, regardless of the X-ray wave-length; by reason of this fact, ionization measurements show a higher absorption of a heterogeneous beam of X-rays by a filter than do energy measurements. Abs. Bull. Kodak Res. Labs.

X-ray Optics. W. L. Bragg. British Journal of Radiology, Feb. 1929, pp. 65-73.

Abbe's theory of the limitations of light in imaging fine structural detail is described in simple terms, and the extent to which this theory can be applied to X-rays is discussed. Our inability to focus X-rays compels us to depend solely on X-ray diffraction for information on the fine structure of matter. Abs. Bull. Kodak Res. Lab.

Testing Installations. C. Sylvester. Kinemat. Weekly, Apr. 18, 1929, pp. 59-60.

Suggestions as to methods of detecting and locating faults (short circuit, leak to earth, or a complete break) in a power or lighting installation. Abs. Bull. Kodak Res. Labs.

(Current Literature Review Continued on Page 20)

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CURRENT LITERATURE REVIEW

Spectrograph Chemical Analysis. H. Ramage. Nature, April 20, 1929, pp. 601-602.

The method devised by the author and Hartley (1897-1901) for spectrographic analysis of minerals is still used with success. In its simplest form, up to 0.5 g. of powdered mineral is tightly rolled in one half of an ashless filter paper, and the roll is burned in an oxy-hydrogen or coal gas flame before the slit of a quartz spectograph, a quartz lens being used to focus the image of the flame on the slit. The delicacy of the test is increased by using an arc with the poles placed horizontally in the flame, a little higher than the point at which the roll of filter paper is being burned, and focusing the image of the arc on the slit. The method has also been applied to the analysis of vegetable and animal substances.—Abs. Bull. Kodak Res. Labs.

Electrometric Determination of Small Quantities of Lead Ion. H. Millet. Trans. Faraday Soc., April 1929, pp. 147-152.

A lead electrode made by electro-deposition of lead on platinum functions well in neutral lead nitrate solutions of low concentration, but less satisfactorily in acid solutions. When no oxygen or carbon dioxide is allowed to come into contact with the lead electrode—in this case a fluid amalgam—minute concentrations of lead can be measured in very acid solutions. Experimental details are given. In dilute solutions of lead ion, the lead electrode functions best if the total ionic strength is made high by the addition of potassium chloride.—Abs. Bull. Kodak Res. Labs.

Static Voltmeter for High Tensions with a Direct Indicator. H. Starke and R. Schroeder. Amer. Jl. Roent., April 1929, pp. 417-418.

This instrument is stated to require no energy consumption, no axis friction, and may be used both for alternating or constant potential for values from a few kilovolts to the highest to be measured; the instrument is easily adjusted and controlled, and is direct reading. (Abstract from Strahlentherapie, 29, 1928, pp. 798-802.)—Abs. Bull. Kodak Res. Labs.

Indication of Hydroxyl in a Water Vapor Discharge Tube. G. L. Lavin and F. B. Stewart. Nature, April 20, 1929, pp. 607.

The presence of OH in the gas coming from a water vapor discharge tube has been demonstrated by photographing the exit tube with a quartz spectrograph. The band at 306 m μ was obtained. Addition of a small quantity of oxygen to the water vapor increases the intensity of the bands. Larger amounts of oxygen give the green oxygen afterglow.—Abs. Bull. Kodak Res. Labs.

Comparison of the Electrostatic and Electromagnetic Methods of X-ray Measurement. E. A. Owen and H. I. Jones. British Jl. Radiology, April 1929, pp. 196-208.

The ionization current produced by X-rays in a standard chamber was measured by both the electrostatic method and the electromagnetic method and found to be in close agreement. The relative advantages of the two methods of measurement are discussed; the electrostatic method is considered somewhat more satisfactory but the use of both, one as a check on the other, is recommended.—Abs. Bull. Kodak Res. Labs.

Comparison of Practical Methods of Measuring Roentgen-ray Quality for Therapy. E. H. Quimby. Amer. Jl. Roent., Jan. 1929, pp. 64-72.

Three methods of quality measurement were compared: absorption coefficients in 0.1 mm. of copper, half-value layer in copper, and effective wave-length determined by absorption in 1 mm. of copper; the first named method was found to correspond most closely to the absorption of X-rays in light substances, and the other methods to absorption of X-rays in heavier substances. In any of these methods, the thickness and kind of filter used for the determination of quality should be specified. The X-ray tube voltage and filtration should also be specified.—Abs. Bull. Kodak Res. Lab.

Interpretation of Stack Gas Analysis. G. E. Salkvist. Blast Furnace and Steel Plant, July 1929, pp. 1055-1057.

Describes a graphic method for calculating deficiencies in fuel utilization in terms of CO. Knowing the amounts of CO_2 and O_2 in the waste gas from combustion.—M. S.

New Research Laboratory at East Chicago. Blast Furnace and Steel Plant, July 1929, pp. 1027-1030.

Illustrated description of equipment and instruments used in the metallurgical laboratory of the American Steel Foundries.—M. S.

Measurement of Specific Heats of Metallurgically Important Materials Over a Larger Temperature Range by Means of Two New Calorimeter Types. (Messung der spezifischen Waermen von metallurgisch wichtigen Stoffen in einem grosseren Temperaturintervall mit Hilfe von zwei neuen Kalorimetertypen.) W. A. Roth and W. Bertram. Zeitschrift fur Elektrochemie und angewandte physikalische Chemie, June 1929, pp. 297-308.

Two new types of a calorimeter, a "buffer-calorimeter" and a "whole-metal calorimeter" are described which were especially developed to measure specific heat at high temperatures. The usual source of error, namely the evaporation of water, is avoided here by dropping the material to be measured into a buffer-mixture. The metal-calorimeter is a hollow aluminum block, the inner temperature of which is measured by 37 thermo-couples. The new calorimeters were used for determining specific heats up to high temperatures, conversion heat, heat of fusion, and formation heat. The tests are described in detail.—Ha.

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CURRENT LITERATURE REVIEW

Humidity Measurement in Operation (Feuchtigkeitsmessung in der Technik). H. Bongards. Messtechnik, June 22, 1929, pp. 153-156.

The dependability of the indications of an ordinary psychrometer in comparison with that of the hair hygrometer is discussed. Operation and calibration of the hair hygrometer and hygrostats are considered.

The Construction and Manufacture of Aircraft Instruments. Instrument World, July 1929, pp. 69-70.

This article briefly mentions the instruments mounted on the airplane instrument board.

The Microscopical Investigation of Textile Fibres and Fabrics. L. G. Lawrie. Instrument World, July 1929, pp. 73-76.

Abstract of a paper read before the Textile Institute. This paper illustrates a few of the uses to which the microscope can be put in the textile industry.

Physical Testing Methods for the Investigation of Sands and Earths (Die Physikalischen Pruefverfahren zur Untersuchung von Sanden und Boden). F. Roll. Messtechnik, June 22, 1929, pp. 156-160.

The history of sand and earth testing methods are briefly considered. This article covers the determination of strength, porosity, density, crystal size, wear and heat conductivity of sands and earths.

The Results of American Klydonograph Measurements (Ergebnisse aus Amerikanischen Klydonographenmessungen). H. Neuhaus. Siemens Zeits., May-June 1929, pp. 368-375.

A correlated abstract of the experiments reported in the Journal of the American Institute of Electrical Engineers, Electric Journal, Electric Light and Power and Electrical World.

"Electrochonous" Synchronous Clocks (Synchronuhren "Electrochonus"). P. Schubert. Zeits. Feinmechanik, June 30, 1929, pp. 1-3.

A new electric clock system, which no longer requires its own circuit, is described. It meets all demands for accuracy, dependability and general applicability.

The Elastic Properties of Thick Cylindrical Shells Under Internal Pressure. G. A. Wedgwood. Proceedings Physical Society, June 15, 1929, pp. 366-383.

The paper gives some information concerning the high-pressure apparatus which was employed, this being designed on the lines suggested by Prof. P. W. Bridgman; a comparison is also made between the working of the roller extensometer developed by Prof. E. H. Lamb and two other extensometers commonly used in engineering laboratories.

A Simple Method of Fitting a Straight Line to a Series of Observations. J. H. Awbery. Proceedings Physical Society, June 15, 1929, pp. 384-391.

A method is described for determining the constants in a straight line to represent a series of data. It has a rational basis, and can be carried out in one-third or one-quarter of the time required to apply the method of least squares; it avoids the multiplications and squarings essential to that method, and has the advantage that at no stage does it necessitate the use of more significant figures than are presented in the data to be analyzed. The results of the method are compared with those obtained by the method of least squares, on some accurate, and also on some very scattered, observational material. In both cases, the saving of time and labor lead to a negligibly small decrease in accuracy, as compared with the older method.

A Hygrometer for Use in Timber-Seasoning Kilns. Ezer Griffiths. Proceedings Physical Society, June 15, 1929, pp. 426-427.

The hygrometer is of the wet and dry bulb type using mercury-in-steel thermometers. The bulbs and capillaries are enclosed in a steel tube which can be inserted through a hole 3 in. in diameter and explorations up to 12 ft. can be made with it. One dial serves both thermometers, the two pointers being arranged so that one moves over the top face of the dial and the other is brought round from beneath on to the outside edge. An electrically operated fan draws air past the two bulbs. The moistening of the covering over the wet bulb is effected in two ways: (a) by a reservoir, (b) by connection to an external water supply.

The Photographic Measurement of the Relative Intensities of the La_1, a_2, a_3 Lines of Silver. H. C. Webster. Proceedings of Physical Society, April 15, 1929, pp. 181-191.

A knowledge of x-ray line intensity is needed in the theory of atomic structure and in chemical analysis by means of x-rays. The relative advantages of the ionization, Geiger counter, and photographic methods of measurements are discussed.

The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua. L. F. Stanley. Proceedings of Physical Society, April 15, 1929, pp. 194-203.

The low-pressure gauge here described consists of a manometer and a compensator of identical construction placed in the opposite arms of a Callendar-Griffiths bridge. Each comprises, essentially, a loop of 10 cm. of platinum wire, 90.001 in. in diameter, together with a compensating loop of 2 cm. of the same wire. The symmetry of the circuit makes errors due to thermo-electric effects very small. Investigations have been carried out to ascertain how the sensitivity of the instrument depends upon (1) the diameter of the gauge; (2) the temperature of the wire; (3) the temperature of the external walls; (4) the nature of the material of the external walls. The gauge follows variations of pressure with considerable rapidity, and its range of measurement is from 2×10^{-3} mm. to 4×10^{-6} mm. approximately.

(Current Literature Review Continued on Page 23)

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CURRENT LITERATURE REVIEW

Specific Heats of Mineral Oils, Determined by a New Method. L. M. Henderson, S. W. Ferris and J. M. McIlvain. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 148-151.

Presented before the Division of Petroleum Chemistry at the Columbus meeting of the American Chemical Society, April 1929. The assembly of the calorimeter is shown by diagram and described. The calorimeter has been used over the range 25 to 250 degrees C.—M.E.H.

Rapid Calibration of Pipets and Burets. Alfred T. Shohl. Ind. and Eng. Chem., Analytical Edition, July 15, 1929, pp. 152-153.

The method proposed is rapid and accurate and involves no special apparatus. It depends upon the specific gravity of mercury.—M.E.H.

An Improved Air-Gas Ratio Apparatus. Crandall Z. Rosecrans. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 156-158.

A gas analysis apparatus of the thermal conductivity type is described, particularly designed for measurements of ratios of air to fuel gas, where the fuel gas may be of any composition. The apparatus is also adaptable for general laboratory work, where concentrations of known gases are to be determined. It consists of a thermal conductivity cell mounted in a constant temperature block controlled by a bimetallic thermostat and an improved Wheatstone bridge gas-analysis circuit.—M.E.H.

A New Plastometer. E. Karrer. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 158-160.

A full description is given of this instrument which measures the plasticity of rubber that does not completely recover in one second after having been compressed.—M.E.H.

Simple Graduated Wash Bottles. Earle R. Caley. Ind. Eng. Chem., Analytical Edition, July 15, 1929, p. 162.

An ordinary graduated cylinder is fitted with stopper and tubing to serve as a wash bottle. —M.E.H.

Determination of the Specific Gravity of Asphalt by Means of a Hydrometer. Hugh R. Berry, Edison H. Smith, and F. R. Lang. Ind. Eng. Chem., Analytical Edition, July 15, 1929, p. 164.

Presented before the Division of Petroleum Chemistry at the Columbus meeting of the American Chemical Society, April 1929. The hydrometer method has been found to be much simpler and much more rapid than the pycnometer method and has given uniformly satisfactory results. —M.E.H.

Electrostatic Method for Determining Fusain in Bituminous Coal. J. D. Davis and J. A. Younkins. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 165-167.

Presented before the Division of Gas and Fuel Chemistry at the Columbus meeting of the American Chemical Society, April 1929. A method for the direct determination of fusain in 60-mesh air-dried coal is presented. It involves preliminary separation of all the fusain in an impure state by gravity and subsequent purification in a current of inert gas by an electrostatic field. The purity of fusain finally recovered is checked by the microscope.M.E.H.

An Improved Volumenometer. Alfred W. Francis and Edward P. Oznard. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 169-170.

The apparatus has given satisfactory results with such materials as soap, leather and various powders. Diagram and description of apparatus, and sample calculation are included.—M.E.H.

Bottle for Accurate Weighing of Volatile Liquid Mixtures. Z. Blaszkowska. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 170-171.

A useful vessel for conveniently weighing out volatile liquid components of a mixture.—M.E.H.

The Minneapolis-Honeywell Heat Regulator. R. Stohn. Zeits. Feinmechanik, June 16, 1929, pp. 1-4.

The Minneapolis Honeywell heat regulators are illustrated and described.

On the Testing of a Novel Photographic Shutter. John S. Anderson. Trans. Opt. Soc., Vol. XXX, No. 4, 1928-29, pp. 165-178.

The paper describes the methods which were adopted at the National Physical Laboratory for measuring the durations of exposure and the efficiencies of a "Louvre" photographic shutter which was recently submitted for test.

The Dependence of the Mobility of Ions in Air on the Relative Humidity. Ezer Griffiths and J. H. Awbery. Proceedings Physical Society, June 15, 1929, pp. 240-247.

The relationship between relative humidity and the mobility of negative ions in air at atmospheric pressure has been examined with a view to possible applications in hygrometric measurements. The method employed was a modification of Zeleny's original method, the end of a wind channel being closed by disc of gauze fitted with a guard ring through which a steady stream of air of definite humidity was pumped.

The motion of the negative ions due to the action of the air stream was balanced by a counter potential gradient, and the mobility was deduced from the critical potential required to produce a balance. The rate of air flow was measured by means of an Ewing ball and tube flowmeter, a hollow glass sphere being used to make it suitable for low air rates. Efforts were made to construct a direct indicating instrument by amplifying the current sufficiently to obtain deflections on a robust moving-coil indicator, but the variations in the amplification factor were found to be too serious.

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CURRENT LITERATURE REVIEW

Measurement of Specific Heats of Metallurgically Important Materials Over a a Larger Temperature Range by Means of Two New Calorimeter Types. (Messung der spezifische Wärmen von metallurgisch wichtigen Stoffen in einen grösseren Temperatur intervall mit Hilfe von zwei neuen Kalorimetertypen.) W. R. Roth and W. Bertram. Zeitschrift für Elektrochemie und angewandte physikalische Chemie, June 1929, pp. 297-308.

Two new types of calorimeters, a "buffer-calorimeter" and a "whole-metal calorimeter," are described which were especially developed to measure specific heats at high temperatures. The usual source of error, namely the evaporation of water, is avoided here by dropping the material to be measured into a buffer-mixture. The metal-calorimeter is a hollow aluminum block the inner temperature of which is measured by 37 thermo-couples. The new calorimeters were used for determining specific heats up to high temperatures, conversion heat, heat of fusion, and formation heat. The tests are described in detail.—Ha.

A Low Power Audio-Frequency Current Supply for General Laboratory Use. C. W. Oatley. Journal of Scientific Instruments, July 1929, pp. 217-220.

A description is given of apparatus for providing alternating current of constant frequency and good wave-form, for use in bridge measurements. The apparatus derives its power entirely from the 100-volt D. C. lighting mains. Arrangements are provided whereby several observers can use the apparatus simultaneously without mutual interference.

A New Electrical Recording System. Bryan H. C. Matthews. Journal of Scientific Instruments, July 1929, pp. 220-226.

This paper describes a new form of moving iron oscillograph, and a valve amplifier designed to work with it, for the recording of very small and rapid fluctuations of e.m.f. Moving systems have been used having natural vibration frequencies of up to 10,000 per second. The instrument gives fairly accurate records of potential waves of about 30 microvolts with a duration of about 2 milliseconds. The system though rapid and sensitive is electrically unbreakable. A new form of standing wave camera is also described.

An Application of the Warren Synchronous Motor to Time Design. L. G. H. Sarsfield. Journal of Scientific Instruments, July 1929, pp. 226-230.

A description is given of a new time switch for use on alternating current circuits and in which a Warren synchronous motor is employed to drive a timing drum. The timing drum makes and breaks a relay circuit used in the present case for controlling the supply to an x-ray installation. A wide range of controlled periods is possible with the arrangement. Some applications of the instrument are suggested.

A New Integrating Microphotometer for X-Ray Crystal Reflections. W. T. Astbury. Journal of Scientific Instruments, Part I, June 1929, pp. 192-196; Part II, July 1929, pp. 209-213.

The development of a new photometric principle has led to the design of an integrating photometer which appears eminently adapted to the measurement of the total intensity in x-ray crystal reflections, and which is capable of extension to other types of radiation also. It is possible to obtain direct proportionality between x-ray intensity and a-ray ionization, when a stripped carbon tissue of the original negative is interposed between a source of a-particles and an ionization chamber. After a short account of its working principles, a description is given of such an a-ray photometer which has been designed and used at the Davy Faraday Laboratory of the Royal Institution.

Pressure Element of Constant Logarithmic Stiffness for Temperature Compensated Altimeter. W. G. Brombacher and F. Cordero. N. A. C. A. Technical Report No. 310.

The usual type of altimeter contains a pressure element, the deflections of which are approximately proportional to pressure changes. An evenly divided altitude scale is secured by using a mechanism between the pressure element and pointer which gives the required motion of the pointer. A temperature-compensated altimeter was constructed at the Bureau of Standards for the Bureau of Aeronautics of the Navy Department, which contained a manually operated device for controlling the multiplication of the mechanism to the extent necessary for temperature compensation. The introduction of this device made it difficult to adjust the muliplying mechanism to fit an evenly divided altitude scale. To meet this difficulty a pressure element was designed and constructed which gave deflections which were proportional to altitude; that is, to the logarithm of the pressure.

The element consisted of a metal bellows of the "sylphon" type coupled to an internal helical spring which was designed so as to have a variable number of active coils. This report presents a description of and laboratory data relating to the special pressure element for the altimeter. In addition equations which apply generally to springs and pressure elements of constant logarithmic stiffness are developed, including the deflection and the spacing between the coils in terms of the constants of the helical spring and pressure element.

(Current Literature Review Continued on Page 27)

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CURRENT LITERATURE REVIEW

Interpretation of Stack Gas Analysis. G. E. Salkvist. Blast Fce & Steel Pt., July 1929, pp. 1055-1057.

Describes a graphic method for calculating deficiencies in fuel utilization in terms of CO, knowing the amounts of CO_2 and O_2 in the waste gas from combustion.—M.S.

New Research Laboratory at East Chicago. Blast Fce & Steel Pt., July 1929, pp. 1027-1030.

Illustrated description of equipment and instruments used in the metallurgical laboratory of the American Steel Foundries.—M.S.

Calibrating Set for Current Measurements. (Kontrollmessatz fur Strommessungen.) El. Zeits., Feb. 28, 1929, pp. 318.

A set of ammeters which fit into suitable sockets can be used to test current consumption up to 100 amp. by attaching them to lamp sockets. Made by Kahnt & Riede, Gera, Germany.—Ha.

Capacity Variometers for Precision Measurements. (Kapazitätsvariatoren für Präzisionsmessungen.) El. Zeits., Feb. 28, 1929, pp. 319.

Description of standard air condensers with quartz insulation and fixed and variable capacity. —Ha.

The Cloudburst Hardness Testing Machine. (Der Cloudburst Haertepruefer.) O. Schlippe. Metallwirtschaft, July 19, 1929, pp. 701-703.

A new hardness testing machine is described and illustrated, which permits hardness tests on an area of twelve square inches by a hail of 10,000 to 20,000 steel balls of three mm. diameter. The new apparatus discloses irregular, not uniform hardness on surfaces and the degree of hardness. Besides these hardness tests, the inventor suggests cold hardening of surfaces by this method. —E.F.

A Modification of the Moving Boundary Method for the Determination of Transference Numbers. H. P. Cady and L. G. Longsworth. Jl. Amer. Chem. Soc., June 1929, pp. 1656-1664.

In this new method the boundary starts at the surface of the metal electrode which furnishes the "indicator" ions by electro-chemical solution of the metal.—M.E.H.

The Condensation of Steam. D. F. Othmer. Ind. Eng. Chem., June 1929, pp. 576-583.

Bibliography of 29 references. An apparatus has been built for studying the effect of temperature, concentration of small amounts of air, and temperature drop on the rate of condensation of steam on an isothermal condensing surface.—M.E.H.

A New Voltmeter Using Water as the Measuring Medium. J. A. Fries. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 123-125.

Description, diagram and use of volumeter are given.—M.E.H.

Bimetallic Electrodes for Titrations Involving a Change of Hydrogen-ion Concentration. Raymond Matthew Fuoss, Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 125-128.

Antimony-lead, antimony-amalgamated copper, bismuth-silver, copper-copper oxide have been used with success. Titration curves are shown for the different pairs.—M.E.H.

Simplified Iodine Pentoxide Apparatus for Determination of Carbon Monoxide in Flue Gas. F. E. Vandaveer and R. C. Gregg. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 129-133.

Presented before the Division of Gas and Fuel Chemistry at the Columbus Meeting of the American Chemical Society, April 1929. The iodine pentoxide apparatus developed by the U. S. Bureau of Standards and the American Gas Association Testing Laboratory may be used successfully for routine analysis of carbon monoxide in concentrations as low as 0.002 per cent in the products of gaseous combustion when: (1) carbon dioxide, oxygen, hydrogen, methane, ethame, hydrogen sufide, sulfur dioxide, nitrogen and oxides of nitrogen are present in small quantities; (2) formaldehyde is present in less than one per cent if one chromic acid tower is heated to 100 degrees C. Correct readings cannot be secured when relatively large quantities, 0.04 to 1.9 per cent of ethylene are present. Bibliography of 27 references.—M.E.H.

Improvements in the Denige's Colorimetric Method for Phosphorus and Arsenic. Emil Truog and A. H. Meyer. In. Eng. Chem., Analytical Edition, July 15, 1929, pp. 136-139.

An improved procedure has been developed which is rapid, more sensitive and accurate than the old. The method should find wide application in biology, agriculture and industry. Procedures for the single and joint determinations of arsenic and phosphorus in a solution are given.—M.E.H.

A Large Metal Soxhlet Extractor. L. R. Bryant. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 139-140.

The extractor is shown drawn to scale and clearly described.

Modification of Parr's Total Carbon Determination in Coal. R. E. Brewer and E. P. Harding. Ind. Eng. Chem., Analytical Edition, July 15, 1929, pp. 145-148.

The changes in design have resulted in an easier control of the temperature, have eliminated the need of compressed air and have made possible a higher accuracy of results. A useful table accompanies the computation. It gives the weight of carbon per milliliter of carbon dioxide at temperatures from 10 to 35 degrees C. and pressures from 720 to 770 mm.—M.E.H.

(Current Literature Review Continued on Page 29)

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CURRENT LITERATURE REVIEW

A Measuring Method for Luminescent Light. (Eine Messmethode fuer Lumineszenslicht.) F. Plotnikow. Zeitschrift für Elektrochemie and angewandte physikalische Chemie, July 1929, pp. 432-434.

A modification of the polarization-colorimeter of Kruess was used to measure luminescence phenomena as f.i. fluorescence, phosphorescence, chemi-luminescence, tribaluminescence, luminescence of bacteria, etc. The method is described and a few data given.—Ha.

Determination of Calorific Power of Gases. (Ueber die Gasheizwertsbestimmung.) Dr. H. Loeffler. Chemische Fabrik, May 8, 1929, pp. 232-233.

Importance of gas-calorimeters which indicate the calorific power at each part of a plant in addition to recording instruments. Detailed description of the Strache-Loeffler calorimeter, called "Caloriscope." Handling of the apparatus and carrying through of measurements in about two minutes with an accuracy of one-third per cent. Measuring range: 700 to 13,000 cal. Accuracy of calibration method. Comparison with similar instruments.—E.F.

Apparatus for Demonstrating Melting and Boiling Point Determinations. (Ein Apparat zur Demonstration von Schmelzpunkts-und Siedepunktsbestimmungen.) W. Schmidt. Chemische Fabrik, June 5, 1929, pp. 279.

A suitable projector for demonstration of melting and boiling points is described.—E.F.

A New Automatic Apparatus for Determination of Water by Distillation. (Ueber einen neuen automatischen Wasserbestimmungesapparat durch Destillation.) J. Pritzker and R. Jungkunz. Chemiker Zeitung, Aug. 3, 1929, pp. 603.

Previous equipments are reviewed. The new device permits simple operation with distilling agents of specific gravities both low and high. Four sketches, a detailed description and some practical results are included. Time for determination in case of 25 per cent water: 5 min.—E.F.

The Bloom Gelometer, A Modern Instrument for Testing of Glue and Gelatin. (Das Bloom Gelometer, ein neu zeitliches Instrument zur Pruefung von Leimen-und Gelantinegallerten.) H. Mendel. Chemiker Zeitung, July 31, 1929, pp. 591-592.

A piston, the diameter of which is kept constant (4 mm.) is loaded in 2 to 5 seconds by small shot. The original finger test is replaced by automatic device determining the strength and the modulus of elasticity and elongation. The apparatus which is distributed by the National Association of Glue Manufacturers, Atlantic City, is illustrated and its operation explained.—E.F.

Two Devices for Facilitating the Testing of Liquids with a Hydrometer. (Zwei Vorrichtungen zur Erleichterung des Spindelns von Fluessigkeiten.) P. Fuchs. Chemiker Zeitung, July 6, 1929, pp. 526-527.

The very practical idea of the first device represents a "reversed measuring cylinder." The density of liquids in flat, hot dishes can easily be determined by sucking parts of the liquid into a tight reversed glass tube in which the hydrometer can float. No pouring is necessary. The second trick, a simple bent wire in narrow cylinders keeps the hydrometer in the center so that no capillar attraction at the wall or rotating of the densimeter complicates the reading.—E.F.

Measurement of Surface Tension in Laboratory and Practice. (Die Messung der Oberflaechenspannung in Laboratorium und Betrieb.) H. Cassel. Chemiker Zeitung, June 19, 1929, pp. 479-480.

Determination of surface tension can be carried out by several methods, the result of which show discrepancies due to "static" and "dynamic" measurement. After critically discussing the facilities available at the present, the author introduces the new apparatus of Strochlein & Co., Braunschweig, which is called a bubble-pressure method. The apparatus, its operation, and its advantages are given.—E.F.

An Improved Adjusting Device for Thermo Regulators. (Eine verbesserte Einstellungsvorrichtung fuer Thermoregulatoren.) F. Friedrichs. Chemiker Zeitung, June 19, 1929, p. 480.

The disadvantages of micrometer screws for the adjustment of the mercury meniscus are avoided by the application of a special ground-in cylinder which is moved by the micrometer screw.—E.F.

Apparatus for Testing Oil (Oelpruefapparat). H. Herbst. Chemiker Zeitung, May 1, 1929, pp. 344-345.

An oil testing apparatus is illustrated and the operation described. The determination of the force of adhesion or the lubrication power of oils on metals and the determination of the edge angle is of interest.—E.F.

Particle Size in Silica. R. H. Aborn and R. L. Davidson. Jl. Franklin Inst., July 1929, pp. 59-71.

The examination of a series of carefully sized powdered silica specimens ranging in average size from 1.73 to 36.0 μ has demonstrated that important part which size distribution plays in the X-ray pattern and the necessity of this distribution before attempting to estimate the average particle size. Distinct qualitative differences have been pointed out in the characteristics of X-ray diffraction patterns of specimens (a) with varying average particle size and the same size of distribution (b) with varying size distribution and the same average particle size. Microphotographic analysis of the patterns gave promising results for a quantitative relationship between pattern characteristics and average particle size when the size distribution was approximately constant. No satisfactory quantitative relation was found between pattern characteristics and varying size distribution.—E.F.

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SOME INSTRUMENTS USED FOR OIL SPRAY STUDY

KALMAN J. De JUHASZ, INSTRUMENTS, Vol. 2, No. 9, September 1929, pp. 299-306, 6 figs.

Two instruments developed by the author at the Engineering Research Laboratories of the Pennsylvania State College:
I. Recording Pendulum for Measuring the Momentum and Mean Velocity of the Oil Spray.
II. A Spray Stroboscope
are described in detail.

MEASUREMENTS—INDUSTRIAL AND SCIENTIFIC

DR. WALTER BLOCK, INSTRUMENTS, Vol. 2, No. 9, September 1929, pp. 307-308.

This is the first installment of a series. The original work is a German Book entitled "Messen und Waegen." A translation will appear in monthly installments.

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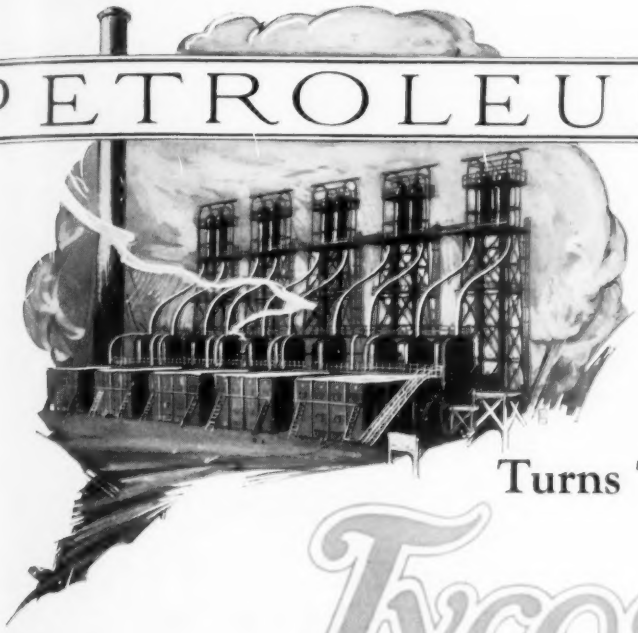

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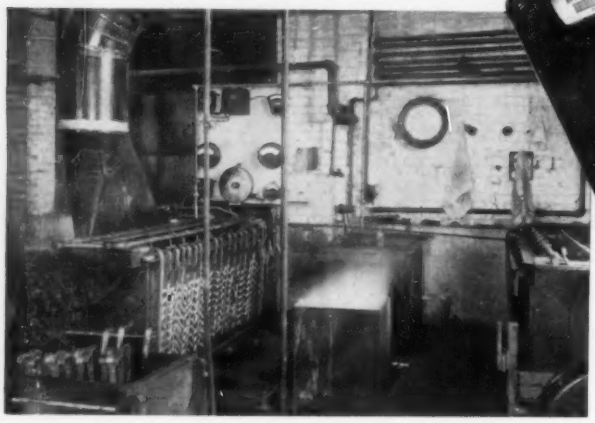

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